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UNITED STATES DEPARTMENT OF AGRICULTURE

DEPARTMENT BULLETIN No. 1183

Washington, D. C. ▼ February 7, 1924

MILLING AND BAKING EXPERIMENTS WITH AMERICAN WHEAT VARIETIES

By

J. H. SHOLLENBERGER, in charge, Milling Investigations, Grain Division
Bureau of Agricultural Economics

and

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Bureau of Plant Industry

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SCOPE OF THE INVESTIGATIONS.

The purpose of this bulletin is to present the results obtained to date from milling and baking experiments conducted by the United States Department of Agriculture with varieties of American wheats.[1] These experiments had two purposes in view: (1) To assist in the promulgation and enforcement of the official grain standards for wheat, and (2) to aid in improving the quality of the wheat grown. The cereal breeders in the department, particularly those engaged in the breeding of wheat, work in cooperation with those engaged in the studies of grain standards and markets.

Before a new variety is distributed, some agency should ascertain if it meets the demand of the market; otherwise it will not be desirable either to the farmer or the miller. It is not enough to introduce a new variety of wheat that yields more than the variety a farmer is now growing. The new variety must be of such quality that the farmer will receive a higher total price for his wheat. Therefore, the plant breeder and the market specialist must work together to see that only those varieties are distributed that are at least as good as the varieties now generally grown. It is

[1] A list of publications treating on American Wheat Varieties is given at the end of this bulletin.

with this second purpose that this bulletin is principally concerned. Careful experiments have been made to determine the comparative value of varieties within each class of the official grain standards for wheat and the relative rank of the varieties in the principal quality-factors considered in commercial milling and baking.

The results obtained furnish a basis for recommending the discontinuance of the production of varieties of poor quality and increasing the production of those of good quality. The experiments have made possible the early determination of the quality of new varieties introduced, or produced by breeding. Several varieties of poor quality have not been distributed for commercial growing because of these experiments and the production of several other varieties has recently been rapidly increased after it was determined that they possessed good milling and bread-making qualities.

The data should be of special value to the milling industry, as the inherent qualities of a variety are the basic and usually the principal factors in the milling and baking value of any sample or lot of wheat. The effects of season, locality, rainfall, elevation, and soil are generally of less importance than varietal differences. The data presented in this bulletin, therefore, should be useful to the producer in determining the best varieties to grow, and, when identification is possible, should be useful to the wheat buyer and miller in selecting and blending wheats to meet particular milling and baking requirements.

General conclusions, based on the milling tests here reported, will be found on page 91.

SOURCES OF THE SAMPLES.

The milling samples on which the data are based were obtained from experiment stations and from commercial sources. In the earlier milling and baking experiments conducted by the Department of Agriculture, dating from 1908 to 1914, the method and equipment used had not been fully developed or standardized and consequently no note is taken here of results obtained previous to the milling of the 1915 crop samples. The chief source of the varietal samples since 1915 has been the numerous experiment stations and substations located in the western United States. The data presented in this bulletin contain the results obtained only during the seven years from 1915 to 1921, inclusive.[2]

The milling and baking experiments with varieties from experiment stations were begun in 1915 upon a uniform set of spring wheat varieties from eight stations in the Great Plains area. Since 1917, samples of varieties from five stations in the Pacific Coast area and samples of winter wheat varieties from additional stations in the western half of the United States have been included.

The commercial samples in recent years have largely been obtained from grain supervisors in the several Federal grain supervi-

[2] The milling and baking experiments were conducted from 1915 to 1917, in the then Office of Grain Standardization of the Bureau of Plant Industry in the milling laboratory operated at Fargo, N. Dak., in cooperation with the department of chemistry of the North Dakota Agricultural Experiment Station. Since 1918 the laboratory has been located at Washington, D. C., and the experiments have been conducted by the section of Milling Investigations of the Grain Division, Bureau of Agricultural Economics. The Office of Cereal Investigations, Bureau of Plant Industry, cooperated by furnishing varietal samples.

sion districts of the United States. These are representative of the quality of wheat coming upon the terminal market during each of the years. A few varietal samples have been obtained from experiment stations in the eastern United States. The Office of Cereal Investigations officially cooperates with most of the experiment stations from which samples were obtained, but since 1920 samples have been obtained from several of the State stations with which the Office of Cereal Investigations has no official cooperation.

Table 1 shows the total number of samples of each class of wheat milled, and Table 2 the number of varietal samples obtained from different experiment stations.

TABLE 1.—*Number of samples of known and unknown variety of each of the various commercial classes of wheat, by crop years, on which the milling and baking data are based.*

Class.	Crop year—							Total.
	1915	1916	1917	1918	1919	1920	1921	
Hard red spring	118	174	237	240	104	205	232	1,310
Durum	22	38	54	47	83	53	135	432
Hard red winter	90	15	76	135	106	101	205	728
Soft red winter	52	38	58	69	80	83	77	457
White	31	64	155	44	84	93	109	580
Total	313	329	580	535	457	535	758	3,507

TABLE 2.—*Number of samples of wheat varieties obtained for milling and baking test from 36 experiment stations in the western United States during the seven crop years 1915 to 1921, inclusive.*

Location of stations.	1915	1916	1917	1918	1919	1920	1921	Total.
Moccasin, Mont	8	13	11	10	12	31	36	121
Havre, Mont			8	10	8	10	18	54
Bozeman, Mont							20	20
Williston, N. Dak	22	14	11				2	49
Dickinson, N. Dak	33	18	21	20	21	22	36	171
Mandan, N. Dak			6	6	7	9	14	42
Edgeley, N. Dak							2	2
Langdon, N. Dak							2	2
Fargo, N. Dak				7			12	19
Crookston, Minn		5	11	7			2	25
St. Paul, Minn						31	39	70
Ashland, Wis							11	11
Brookings, S. Dak	13	13	12	12			6	56
Highmore, S. Dak	13	12	13	11	9		6	64
Eureka, S. Dak							6	6
Redfield, S. Dak							4	4
Newell, S. Dak	11	11	16		12		3	53
Sheridan, Wyo			14	15	1	10	15	55
Archer, Wyo	11	12	13	21	17	23	26	123
Lincoln, Nebr							10	10
North Platte, Nebr		12	11	8	11	5	11	58
Akron, Colo	10	13	13	14	15	25	42	132
Hays, Kans						7	21	28
Manhattan, Kans						6	15	21
Amarillo, Tex		11	12	9				32
Lind, Wash			10	15	17	20	24	86
Pullman, Wash						18	22	40
Moscow, Idaho						6	6	12
Aberdeen, Idaho			10	11	6	7	8	42
Moro, Oreg			13	19	19	14	31	96
Burns, Oreg			10	5	11	25	26	77
Corvallis, Oreg						12		12
Logan, Utah						6		6
Nephi, Utah			10	14	14	13	17	68
Chico, Calif			12	18	21	17	18	86
Davis, Calif						3	11	14
Total	121	134	237	232	201	320	522	1,767

IMPORTANCE OF FACTORS DETERMINING THE QUALITY OF WHEAT.[3]

MILLING YIELD AND FLOUR AND BREAD COLOR.

The term "milling quality" has a varied meaning, and in speaking of wheat of high milling quality two millers may have very different standards in mind. Broadly speaking, any wheat which will yield a high percentage of white, sound flour is of good milling quality. Flour yield, or the quantity of flour of good color that can be produced from wheat, is always the most important consideration in judging wheat. Other factors are of importance in deciding the purpose for which the flour from a certain kind of wheat is best adapted, but they usually play a minor part in determining values.

Flour yield and flour color, or the color of the bread produced from the flour, must always be considered together, as they are closely related in their commercial significance. Yield is the quantitative expression of the amount of flour that can be produced from wheat, while color is the chief factor in determining the grade of the flour and consequently its selling price.

Flour yields in the following pages are expressed as a percentage of straight flour. The term "straight" in this connection has much the same significance as it has commercially, and includes all of the flour usually included in the "patent" and "clear" grades.

The color-scoring system used for bread is based upon an arbitrary scale on which the highest markings are 100, but only very exceptional breads score 100. The scoring is decided upon by comparison with loaves from check or standard flours. Bread from flour made from ordinary sound wheat will score usually between 90 and 100. Bread that will not score more than 50 is from flour of such poor quality that it would be classed with the lowest grade of commercial flours, such as "red dog."

FLOURS OF HIGH AND OF LOW STRENGTH.

The definition given for a wheat or high quality holds good only when no consideration is given to the remarkable variation in the working qualities of different flours in the hands of the baker. Strength may be defined as that quality in flour which enables the baker to produce a loaf of bread of large volume and of good texture by use of the proper ingredients, together with proper mixing, fermentation, and baking. From this definition it will be apparent that strength is of great importance in the making of ordinary fermented bread. For other food products, however, high strength is not required and is not even desirable. This is especially true in the manufacture of products in which chemical leavening agents are used in place of yeast. Low-strength flours are preferable in the making of crackers and of practically all pastry, as they yield products that are free from undesirable toughness and, on the other hand, are either flaky, brittle, or crumbly, as the character of the product demands; and this result is attained with a saving in the quantity of lard or other shortening required as compared with what is necessary for stronger flours.

[3] Abstracted from Department Bulletin 557: A comparison of several classes of American wheats and a consideration of some factors influencing quality, by L. M. Thomas.

In the manufacture of macaroni and similar products, although strong flours are not necessary, ordinary low-strength flours are not at all suitable. The essential requirements of wheat for making flour for these purposes are that it shall be hard in texture and of such character that it will pulverize into a coarse granular flour, or, as it is more often called, "semolina," and that this be glutenous, or high in gluten proteids. The first of these requirements seems to facilitate the mechanical part of the manufacture, while the second improves the quality of the product by preventing disintegration during cooking.

LOAF VOLUME AND TEXTURE.

This leads to a consideration of the measure of strength in flour. The definition of strength already given mentions two factors as of importance, namely, size and texture of loaf. A measure of the volume of the loaf gives the desired information as to size, and in the following pages this is expressed in cubic centimeters. The figures are comparative, as in every case 340 grams of flour were used for a loaf. It is more difficult to express texture in absolute terms, as it is dependent upon several related considerations. The uniformity, number, and evenness of distribution of cavities are the most important points. For a loaf to be of good texture the walls of the cells should be thin and nearly transparent. To obtain a measure of texture it has been found necessary to resort to an arbitrary scoring system based on the ideal as 100.

WATER ABSORPTION.

Capacity of water absorption is of some commercial importance and is determined by measuring the water added in mixing the dough. It is important because of its relation to the weight of the baked loaf. It might be considered as one element in the strength of flour if the definition were changed to include, besides requirements for lightness and texture of loaf, a requirement for a high yield of bread per unit quantity of flour.

METHODS USED IN DETERMINING MILLING AND BAKING QUALITIES.

Determination of the milling and baking qualities of the different varieties was made with experimental or laboratory equipment rather than with the type of equipment used in commercial establishments. The results obtained, however, are considered truly indicative of commercial values.

The total quantity of wheat for the individual tests was 1,800 grams, of which 1,500 grams were milled. From this quantity of wheat sufficient flour for two baking tests was produced, 340 grams of flour being used in each test.

The type of experimental mill used is shown in Figure 1 and consists of four pairs of 6-inch rolls (three corrugated and one smooth), a sifter, and sieves appropriate for making the various separations of stock required. The system of milling used, although not the continuous automatic system employed in commercial mills,

included all the various steps deemed necessary in modern milling practice.

The procedure followed in making each test consisted in grading the wheat in accordance with the requirements of the official grain standards for wheat, cleaning and scouring by use of small machines modeled after the types found in ordinary mills, tempering in order to put the wheat in proper milling condition, milling, baking bread from the flour product, scoring and judging the quality of the bread, and making certain chemical determinations on the wheat and the flour. The methods used in making these tests are more fully described in Department Bulletin No. 1187.

The test-weight-per-bushel determinations were made by the method prescribed in Department Bulletin No. 472, for use in connection with the inspection of grain under the United States grain standards act.

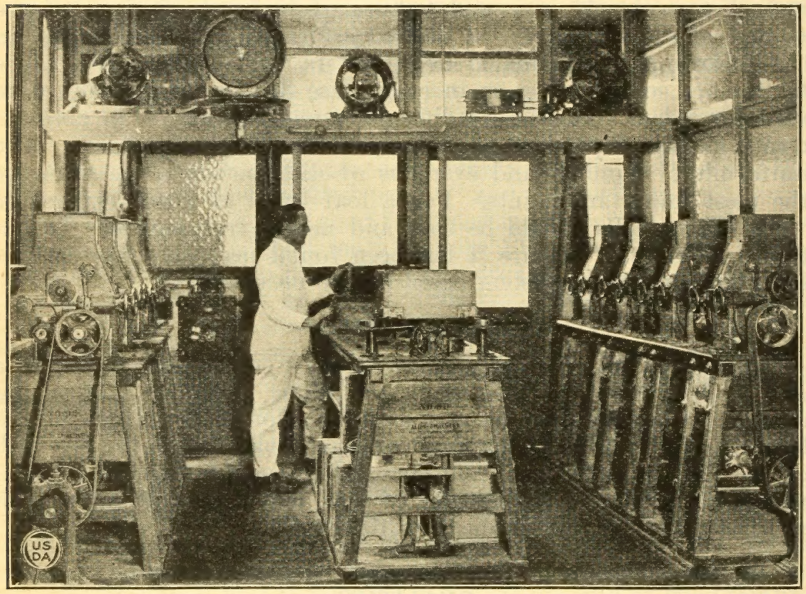


FIG. 1.—Experimental milling equipment.

The milling yields given in this bulletin are in terms of percentage based on the total weight of the flour, shorts, and bran produced.

The crude protein content of the wheat (nitrogen×5.7) and the ash content of the flour were computed to a uniform basis of 13.5 per cent moisture. Because of the deleterious effect of smut, the color score of all smutty samples was excluded from the tabulations.

EFFECT OF LOCALITY AND CROP YEAR ON QUALITY.

Although variety is the primary cause of differences in quality of wheat, there is a considerable variation within a variety because of various environmental factors. Principal among these are locality and season. To illustrate the variations that occur within a variety, the results obtained from individual samples of the Marquis variety

obtained from 12 stations in the western United States during the five crop years from 1917 to 1921, inclusive, are shown in Tables 3 to 7. Five of the more important grading, milling, and baking factors are shown: Test weight per bushel, crude protein, yield of flour, water absorption of flour, and volume of loaf.

TEST WEIGHT PER BUSHEL.

In Table 3 is shown the test weight per bushel of the mill-cleaned and scoured samples of five crops of Marquis wheat produced at 12 experiment stations, or a total of 60 samples. The samples varied in test weight from 51.5 pounds from Archer, Wyo., in 1919, to 65 pounds from Chico, Calif., in 1917. The average test weight per bushel for all of the 60 samples was 58.6 pounds. In 1917 the samples from the 12 stations had the heaviest test weight, averaging 60.1 pounds, and in 1919 the lightest test weight, averaging only 57.4 pounds. The heaviest average test weight per bushel for the stations was obtained from the station at Chico, Calif., where the samples averaged 62.2 pounds per bushel. They were the lightest from the station at Moro, Oreg., averaging only 54.5 pounds per bushel during the five-year period. The greatest range between crop years in test weight per bushel for any of the stations was 11.5 pounds, which was for Archer, Wyo., and the greatest range between stations for any of the five crop years was 11.1 pounds. These ranges are high, indicating that both season and location may have considerable effect on test weight per bushel.

TABLE 3.—*Annual and average test weight per bushel of mill-cleaned and scoured samples of the Marquis wheat grown at 12 experiment stations in the western United States during the five years from 1917 to 1921, inclusive.*

Station.	1917	1918	1919	1920	1921	Average.	Range.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Moccasin, Mont.	62.0	61.5	60.9	62.3	61.2	61.6	1.4
Havre, Mont.	58.0	61.7	59.0	57.8	58.6	59.0	3.9
Dickinson, N. Dak.	61.0	60.9	60.2	59.0	57.9	59.8	3.1
Mandan, N. Dak.	60.0	61.4	59.4	60.5	52.3	58.7	9.1
Archer, Wyo.	63.0	58.7	51.5	55.4	60.1	57.7	11.5
North Platte, Nebr.	60.0	58.4	53.5	54.0	58.2	56.8	6.5
Akron, Colo.	59.0	57.4	57.3	55.5	56.5	57.1	3.5
Lind, Wash.	56.5	57.0	56.3	58.0	57.7	57.1	1.7
Moro, Oreg.	55.5	55.3	53.5	53.4	55.0	54.5	2.1
Burns, Oreg.	62.5	57.5	57.0	59.4	57.2	58.7	5.5
Aberdeen, Idaho.	59.0	60.7	[1] 59.5	[1] 59.9	[1] 63.4	60.5	4.4
Chico, Calif.	65.0	61.7	60.9	61.2	62.2	62.2	4.1
Average.	60.1	59.4	57.4	58.0	58.4	58.6	4.7
Range.	9.5	6.4	9.4	8.9	11.1	9.1	.....

[1] Grown under irrigation.

CRUDE PROTEIN IN THE WHEAT.

Table 4 shows the variations obtained in the determination of crude protein content of the wheat (N×5.7, basis 13.5 per cent moisture) from the 60 samples of the Marquis variety. The individual samples are shown to vary from 7.5 per cent from a sample grown at Chico, Calif., in 1919, to 19.6 per cent from a sample grown at Havre, Mont., in 1920, the 60 samples averaging 15.1 per cent. The highest yearly average for the 12 stations was 15.9 per

cent in 1917, and the lowest 14.5 per cent in 1918. The samples from Chico, Calif., were the lowest in crude protein, averaging only 8.9 per cent for the five years, while those from Havre, Mont., were the highest, averaging 17.5 per cent. That locality had a greater effect on the crude protein content than season is evidenced by the fact that the ranges in percentage for the samples from the various stations for individual crop years are much higher than those between crop years for the individual stations. The average yearly range between stations was 9.5 per cent, while the station average range between crop years was only 3.3 per cent.

TABLE 4.—*Annual and average percentage of crude protein in samples of Marquis wheat grown at 12 experiment stations in the western United States during the five years from 1917 to 1921, inclusive.*

Station.	1917	1918	1919	1920	1921	Average.	Range.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Moccasin, Mont.	14.5	15.7	16.8	14.8	14.5	15.3	2.3
Havre, Mont.	18.6	14.6	17.1	19.6	17.6	17.5	5.0
Dickinson, N. Dak.	16.6	14.2	17.4	15.2	19.2	16.5	5.0
Mandan, N. Dak.	16.5	12.5	14.9	16.1	17.1	15.4	4.6
Archer, Wyo.	14.8	14.5	15.7	14.3	11.9	14.2	3.8
North Platte, Nebr.	17.4	14.6	13.0	12.6	11.7	13.9	5.7
Akron, Colo.	17.5	16.9	15.9	17.5	17.5	17.1	1.6
Lind, Wash.	14.1	14.3	14.5	14.9	14.6	14.5	.8
Moro, Oreg.	16.7	16.1	14.9	16.8	14.0	15.7	2.8
Burns, Oreg.	15.9	[1] 15.7	16.6	16.4	16.7	16.3	1.0
Aberdeen, Idaho	16.7	15.4	[1] 14.5	[1] 16.9	[1] 13.1	15.3	3.8
Chico, Calif.	11.1	10.0	7.5	7.9	7.9	8.9	3.6
Average	15.9	14.5	14.9	15.2	14.6	15.1	3.3
Range	7.5	6.9	9.9	11.7	11.3	9.5	.....

[1] Grown under irrigation.

YIELD OF STRAIGHT FLOUR.

Yields of straight flour obtained from the individual samples of Marquis wheat grown in the 60 tests are shown in Table 5. The lowest yield of flour obtained from any of the samples of Marquis was from a sample grown at Mandan, N. Dak., in 1921, when only 60.2 per cent of flour was obtained. The highest yield was from a sample grown at Chico, Calif., in 1918, which yielded 76.2 per cent. The 60 samples gave an average yield of 70.3 per cent flour. In 1918, samples from the 12 stations produced the highest yield with an average of 72.3 per cent flour. The lowest average for the 12 stations was from the 1921 crop, with a yield of 69 per cent. The highest average flour yield from any station was obtained from samples from Aberdeen, Idaho, which was 73.7 per cent for the five-year period. During the three years 1919 to 1921, inclusive, these samples were grown under irrigation. Samples from North Platte, Nebr., produced the lowest average yield of flour, being 68.2 per cent for the five-year period. The greatest range in flour yield between crop years for any of the stations was 15.3 per cent for Mandan, N. Dak., and the greatest range between stations for any crop year was 14.9 per cent. These figures indicate that both locality and season have an influence on flour yield, but the extent of this influence is difficult to determine because of the high experimental error to which the test may be subjected, and because of the relationship existing between test weight per bushel and flour yield.

TABLE 5.—*Annual and average percentage yield of straight flour from samples of Marquis wheat grown at 12 experiment stations in the western United States during the five years from 1917 to 1921, inclusive.*

Station.	1917	1918	1919	1920	1921	Average.	Range.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Moccasin, Mont.	71.4	72.4	73.7	72.5	71.3	72.3	2.4
Havre, Mont.	67.3	71.6	72.6	68.3	72.9	70.5	5.6
Dickinson, N. Dak.	71.4	73.7	67.8	68.7	65.6	69.4	8.1
Mandan, N. Dak.	70.2	75.5	68.3	73.6	60.2	69.6	15.3
Archer, Wyo.	74.1	73.4	64.8	69.0	71.1	70.5	9.3
North Platte, Nebr.	66.6	70.2	68.9	63.3	72.2	68.2	8.9
Akron, Colo.	69.6	69.7	65.6	69.2	68.0	68.4	4.1
Lind, Wash.	69.1	72.0	67.1	71.1	67.0	69.3	5.0
Moro, Oreg.	69.4	71.7	67.5	67.0	66.4	68.4	5.3
Burns, Oreg.	74.3	[1] 68.8	73.5	72.7	68.8	71.6	5.5
Aberdeen, Idaho.	72.5	71.9	[1] 74.6	[1] 74.5	[1] 75.1	73.7	3.2
Chico, Calif.	73.0	76.2	69.9	72.1	70.4	72.3	6.3
Average.	70.7	72.3	69.5	70.2	69.1	70.3	6.6
Range.	7.7	7.4	9.8	11.2	14.9	10.2	.....

[1] Grown under irrigation.

WATER ABSORPTION OF FLOUR.

Water absorption of the flour from 60 samples of Marquis wheat grown at 12 experiment stations in the western United States during the five years from 1917 to 1921 is shown in Table 6. The data show that the individual samples vary in water absorption from 52.9 per cent from a sample grown at Chico, Calif., in 1919, to 67.1 per cent from a sample grown at Aberdeen, Idaho, under irrigation in 1920. The average for the 60 samples is 60.1 per cent water absorption.

There was little difference in the average from all of the stations for the different years. Samples from Chico, Calif., show the lowest water absorption, averaging only 56.8 per cent, while those from Havre, Mont., had the highest absorption, averaging 61.8 per cent. The influence of both season and locality on water absorption is very marked, as is indicated by the number of high ranges in percentages for the samples from the individual stations and between stations for the individual crop years. The highest range for a station was 10.9 per cent for Aberdeen, Idaho, and the highest range for the crop years was 11.8 for the 1919 crop.

TABLE 6.—*Annual and average percentage of water absorption of flour samples of Marquis wheat grown at 12 experiment stations in the western United States during the five years from 1917 to 1921, inclusive.*

Station.	1917	1918	1919	1920	1921	Average.	Range.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Moccasin, Mont.	60.0	62.6	62.1	59.7	60.6	61.0	2.9
Havre, Mont.	58.2	60.3	63.5	64.4	62.6	61.8	6.2
Dickinson, N. Dak.	57.9	55.3	61.5	58.2	62.6	59.1	7.3
Mandan, N. Dak.	57.1	58.2	60.3	62.6	65.3	60.7	8.2
Archer, Wyo.	61.2	60.0	62.6	60.6	62.6	61.4	2.6
North Platte, Nebr.	63.2	55.9	56.2	56.8	58.2	58.1	7.3
Akron, Colo.	59.1	59.4	60.6	58.8	61.2	59.8	2.4
Lind, Wash.	59.7	60.3	62.9	61.8	59.1	60.8	3.8
Moro, Oreg.	59.4	57.6	58.5	60.9	56.8	58.6	4.1
Burns, Oreg.	59.7	[1] 61.5	64.7	60.3	59.4	61.1	5.3
Aberdeen, Idaho.	61.5	56.2	[1] 62.4	[1] 67.1	[1] 59.1	61.3	10.9
Chico, Calif.	58.8	59.1	52.9	56.2	56.8	56.8	6.2
Average.	59.7	58.9	60.7	60.6	60.4	60.1	5.6
Range.	6.1	7.3	11.8	10.9	8.5	8.9	.....

[1] Grown under irrigation.

LOAF VOLUME.

The loaf volume obtained from the same samples of Marquis wheat is shown in Table 7. The average loaf volume for the 60 tests is 2,260 cubic centimeters. The lowest loaf volume was obtained from a sample grown at Chico, Calif., in 1919, which produced a loaf measuring only 1,720 cubic centimeters. The largest loaf was obtained from a sample grown at Dickinson, N. Dak., in 1919, which produced a loaf measuring 2,860 centimeters. The 1919 samples averaged highest in loaf volume for all stations, and those for 1920 averaged lowest. During the five-year period samples from Chico, Calif., averaged only 1,914 cubic centimeters, while the samples from Dickinson, N. Dak., produced the largest loaves, averaging 2,574 centimeters. In the matter of loaf volume, it appears from the ranges given that locality has a greater influence than season. The average yearly range for the 12 stations was 790 cubic centimeters, while the average station range for the five crop years was only 482. The greatest range between stations for any crop year was 1,110 cubic centimeters for the year 1919 and the greatest station range between crop years was 780 cubic centimeters for Aberdeen, Idaho.

TABLE 7.—*Annual and average volume of loaf of samples of Marquis wheat grown at 12 experiment stations in the western United States during the five years from 1917 to 1921, inclusive.*

Station.	1917	1918	1919	1920	1921	Average.	Range.
	C. c.	*C. c.*	*C. c.*	*C. c.*	*C. c.*	*C. c.*	*C. c.*
Moccasin, Mont.	2,300	2,160	2,220	2,330	2,130	2,228	200
Havre, Mont.	2,180	2,090	2,490	1,880	2,460	2,220	610
Dickinson, N. Dak.	2,350	2,740	2,860	2,330	2,590	2,574	530
Mandan, N. Dak.	2,500	2,370	2,360	2,430	2,140	2,360	360
Archer, Wyo.	2,150	2,070	2,610	2,090	2,400	2,264	540
North Platte, Nebr.	2,240	2,440	2,340	2,260	2,070	2,270	370
Akron, Colo.	1,900	2,450	2,180	2,420	2,260	2,242	550
Lind, Wash.	2,530	2,030	2,430	1,900	2,290	2,236	630
Moro, Oreg.	2,240	2,600	2,280	2,140	2,190	2,290	460
Burns, Oreg.	2,125	[1] 2,240	2,300	2,440	2,330	2,287	315
Aberdeen, Idaho.	2,030	2,360	[1] 2,700	[1] 1,920	[1] 2,150	2,232	780
Chico, Calif.	2,260	2,000	1,720	1,800	1,790	1,914	440
Average.	2,234	2,296	2,374	2,162	2,233	2,260	482
Range.	630	740	1,140	640	800	790	.....

[1] Grown under irrigation.

SUMMARY OF INDIVIDUAL SAMPLES.

These individual samples show that wide variations, due to both season and locality, occur within a variety in the principal milling and baking quality factors. The data show that in crude protein and volume of loaf locality has a greater influence than season, but just what peculiarity of conditions of either locality or season is most conducive to good results is not shown. No doubt soil fertility, soil condition as pertains to seed-bed preparation, time of sowing, stage of maturity at time of harvesting, weather conditions before seeding and during the growing season and at the time of maturity, and altitude, all combine to influence the resultant qualities of a sample. The data also show the necessity of obtaining a large number of samples in order to determine accurately the milling and baking values of different varieties of wheat. The milling quality of any variety from a single locality in any year therefore is unreliable in

determining the milling value of the variety. These experiments have also shown that tests of several samples from different localities are necessary before much is known regarding the milling qualities of a variety. Results from two or three tests, however, will give some indication of its milling value, but no definite reliance should be placed upon results of less than five tests. Therefore no data are presented in this bulletin for any variety with which less than five tests have been made. The greater the number of tests, the more reliable are the results. After 60 or more samples of a variety have been tested, the average of results will be only slightly affected by the variations due to locality or season.

MILLING AND BAKING VALUE OF VARIETIES.

Under the official grain standards of the United States wheat is now graded into five commercial classes,[4] as follows: (1) Hard red spring, (2) durum, (3) hard red winter, (4) soft red winter, and (5) white. The milling and baking results from varieties are discussed under these classes.

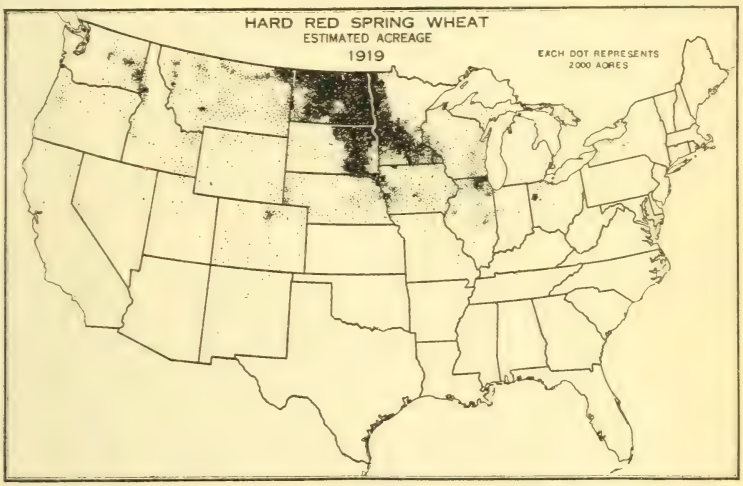


FIG. 2.—Distribution of wheat of the Hard Red Spring class.

THE HARD RED SPRING WHEATS.[5]

The commercial class of wheat known as hard red spring, in which are included all the varieties of hard red spring common wheat, is grown principally in the north central part of the United States, where the winters are too severe for winter wheat to be grown safely. The States of North Dakota, Minnesota, South Dakota, and Montana lead in its production. A map showing the distribution of hard red spring wheat in 1919 is shown in Figure 2. Nearly

[4] For complete information regarding classes, see Handbook of Official Grain Standards for Wheat, Shelled Corn, and Oats. U. S. G. S. A. Form No. 90. Revised and reprinted Sept., 1922.

[5] For more complete information concerning the varieties and adaptation of hard red spring wheat, see Clark, J. Allen, Martin, John H., and Smith, Ralph W.: Varietal Experiments with Spring Wheat on the Northern Great Plains, U. S. Dept. Agr., Bul. 878, 1920; and Clark, J. Allen, and Martin, John H.: The Hard Red Spring Wheats, U. S. Dept. Agr., Farmers' Bul. 1281, 1922.

14,000,000 acres of this class of wheat are grown annually in the United States, comprising nearly one-fourth of the total wheat acreage. In 1919, as shown in Table 8, the acreage exceeded 16,000,000 acres.

Although 24 distinct varieties of hard red spring wheat are grown, about two-thirds of the acreage of this class consists of the one variety, Marquis. This variety is taken as the standard for comparing all other varieties of hard red spring wheat. Milling and baking experiments have been made with nearly all of the 24 varieties, but tests of 5 or more samples have been made with only 17 of these. A summary of the results obtained from all samples of these 17 varieties of hard red spring wheat are shown in Table 9.

TABLE 8.—*Estimated acreage of hard red spring wheat, 1919.*

State.	Acres.	State.	Acres.
North Dakota	6,301,900	Nebraska	375,500
Minnesota	3,423,600	Washington	239,400
South Dakota	3,038,500	Idaho	202,000
Montana	820,000	Other	468,800
Iowa	537,600		
Illinois	520,100	United States	16,326,800
Wisconsin	399,400		

TABLE 9.—*Summary of milling and baking data on hard red spring wheat varieties grown during the seven years from 1915 to 1921, inclusive.*

Variety.	Number of samples.[1]	Test weight per bushel.		Crude protein of wheat.	Milling yields.			Baking results.					Ash in flour.
		Dockage-free wheat.	Mill-cleaned wheat.		Straight flour.	Shorts.	Bran.	Water absorption of flour.	Loaf.				
									Volume.	Weight.	Texture.	Color.	
		Lbs.	*Lbs.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*C. c.*	*Gms.*	*Score.*	*Score.*	*P. ct.*
Chul	16	58.1	59.4	13.9	71.2	15.5	13.3	61.1	1,935	501	90.1	91.7	0.49
Dakota	6	50.4	53.2	11.2	67.7	14.0	18.3	58.9	2,358	485	91.7	90.8	.....
Ghirka	43	57.0	58.4	14.1	66.6	17.9	15.5	60.1	2,114	495	86.9	88.3	.47
Glyndon	36	56.3	57.9	15.5	69.5	15.8	14.7	60.3	2,137	494	88.1	89.3	.47
Haynes Bluestem	128	53.6	55.7	13.4	68.1	15.6	16.3	60.6	2,246	493	89.9	89.1	.49
Humpback	62	58.8	60.2	11.6	72.5	13.0	14.5	54.2	1,833	480	86.7	87.5	.44
Kitchener	9	57.2	58.6	13.9	71.4	14.0	14.6	60.4	2,171	504	89.6	90.6	.48
Kota	38	58.9	60.7	15.4	71.1	15.0	13.9	64.2	2,257	506	90.8	88.7	.58
Marquis	406	56.6	58.6	13.1	69.3	15.9	14.8	59.6	2,274	491	90.9	90.8	.50
Norka	9	59.7	61.2	16.4	71.8	16.1	12.1	60.8	1,824	502	88.8	87.3	.54
Pioneer	60	57.7	58.8	16.1	70.6	16.8	12.6	60.8	2,311	496	90.3	90.4	.49
Power	62	57.5	58.8	16.0	70.9	14.9	14.2	61.5	2,119	501	87.8	89.0	.46
Prelude	58	58.7	59.4	16.6	72.1	15.5	12.4	60.0	2,279	496	87.9	87.8	.52
Preston	119	57.7	59.1	14.0	68.7	16.2	15.1	59.8	2,199	491	88.2	89.0	.48
Red Bobs	20	56.1	57.2	14.2	71.5	13.6	14.9	60.2	2,248	498	89.7	90.7	.49
Red Fife	34	56.3	58.3	12.6	69.2	15.5	15.3	59.9	2,252	492	89.6	90.8	.40
Ruby	22	58.2	59.6	15.4	70.1	15.5	14.4	62.4	2,188	506	89.3	92.7	.51
Average of varietal samples (Max. No. 1128)		56.8	58.5	13.9	69.6	15.7	14.7	59.9	2,210	493	89.5	89.8	.49
Average[2] of class (Max. No. 1310)		56.9	.....	13.6	69.3	15.3	15.4	59.4	2,142	493	89.5	89.3	.50

[1] This column contains the maximum number of samples used for each variety. In some instances, particularly for the factors of loaf color and ash, the results given represent the average of a fewer number of samples for the reason that complete data on all the samples were not available. The number of samples used for the various factors is given in Figures No. 12 to 23, inclusive.

[2] Average of all hard red spring wheat samples on which tests were made, including the varietal samples shown above.

Only the average results obtained from each of the varieties are given. The limits of this bulletin prevent the tabulation of the results from individual samples or the results for different years. In Table 9 the varieties are arranged in alphabetical order, without regard to the number of samples of each which have been milled or to the agricultural importance of the varieties. The number and sources of the samples by States are given in Table 10.

TABLE 10.—*Number of samples of each variety of hard red spring wheat grown in each State, the data on which are shown in Table 9.*

Variety.	North Dakota.	Minnesota.	South Dakota.	Montana.	Wyoming.	Colorado.	Nebraska.	Idaho.	Oregon.	Washington.	Texas.	Ohio.	California.	Utah.	Kansas.	Wisconsin.	Origin unknown.	Total.
Chul	....	....	....	....	....	....	....	2	5	2	....	....	3	4	....	....	....	16
Dakota	6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	6
Ghirka	13	3	6	3	6	6	4	....	....	....	2	....	....	....	....	....	....	43
Glyndon	7	3	8	3	6	5	2	....	....	....	2	....	....	....	....	....	....	36
Haynes Bluestem	74	11	14	11	8	7	2	....	....	....	1	....	....	....	....	....	....	128
Humpback	5	54	....	....	....	....	2	....	....	....	....	....	....	....	....	....	1	62
Kitchener	1	2	....	3	2	1	....	....	....	....	....	....	....	....	....	....	....	9
Kota	14	3	6	5	2	2	2	....	1	1	....	....	....	....	1	1	....	38
Marquis	178	45	44	19	11	8	7	32	15	21	2	12	6	4	1	1	....	406
Norka	1	....	....	3	4	1	....	....	....	....	....	....	....	....	....	....	....	9
Pioneer	10	3	12	9	10	7	6	....	....	....	3	....	....	....	....	....	....	60
Power	18	2	10	12	10	5	2	....	....	....	3	....	....	....	....	....	....	62
Prelude	11	4	13	5	8	7	7	....	....	....	3	....	....	....	....	....	....	58
Preston	41	17	22	12	10	8	4	....	1	....	3	....	....	....	1	....	....	119
Rde Bobs	4	1	....	4	1	1	1	....	7	1	....	....	....	....	....	....	....	20
Red Fife	30	2	....	....	....	....	....	1	....	....	....	....	....	....	....	....	1	34
Ruby	4	2	....	4	5	2	....	....	4	1	....	....	....	....	....	....	....	22
Total	417	152	135	93	83	60	39	35	33	26	19	12	9	8	3	2	2	1,128

In many of the varieties a considerable number of the samples milled are directly comparable with samples of Marquis. That is, the two varieties have been grown at experiment stations under similar conditions during the same years. A comparison of the results from these comparable samples of the several varieties with those of Marquis makes possible a more accurate determination of the milling and baking qualities of each of the varieties than is shown by the average of all samples. The varieties are discussed in the order in which they appear in Table 9, and where accurate comparisons are possible, separate tables showing these data are presented. The relative differences between each of the varieties and of Marquis are shown in tabular form for the more important varieties, the value of Marquis for all characters being taken as 100. Photographs showing the relative differences in the quality of bread made from some of the principal varieties of this class of wheat are found in Plate I.

Chul.—The Chul variety was introduced by the United States Department of Agriculture from Russian Turkestan in 1902. It is a bearded, glabrous, white-glumed variety, having large, very hard kernels which resemble durum wheat. The original seed was a mixture of red and white kernels, the greater part being red. The name Chul has been continued for the red-kerneled portion, and the white-kerneled strain is called Talimka. Both types have been grown sep-

arately at experiment stations, but a part of the original introduction, which consisted of 100 pounds, was distributed to farmers. The wheat grown commercially under the name Chul, therefore, usually is a mixture of Chul and Talimka. Chul and Talimka are grown commercially only in California and Nevada, where less than 2,000 acres were reported in 1919.

Sixteen samples of Chul wheat have been milled and baked in the milling laboratory. These samples were obtained from experiment stations in Oregon, Idaho, Utah, California, and Washington during the three years from 1917 to 1919, and one sample was obtained from Utah in 1921. Twelve of the samples milled are directly comparable with an equal number of Marquis samples. A summary of these results are shown in Table 11.

The Chul variety is a very hard wheat and is, therefore, somewhat difficult to mill. It has slightly exceeded Marquis in test weight per bushel, but has a lower crude protein content. It has approximately equaled Marquis in yield of flour, shorts, and bran, and has a considerably higher water absorption. It is inferior to Marquis in volume, texture, and color of loaf, three important bread-quality factors. It is not used in the manufacture of bread-making flour.

Chul has not yielded well except in the Pacific Coast States and even there it is much inferior to the more productive varieties of white wheat. The weak straw of Chul frequently causes lodging and makes the crop difficult to harvest. The growing of Chul wheat should be discontinued.

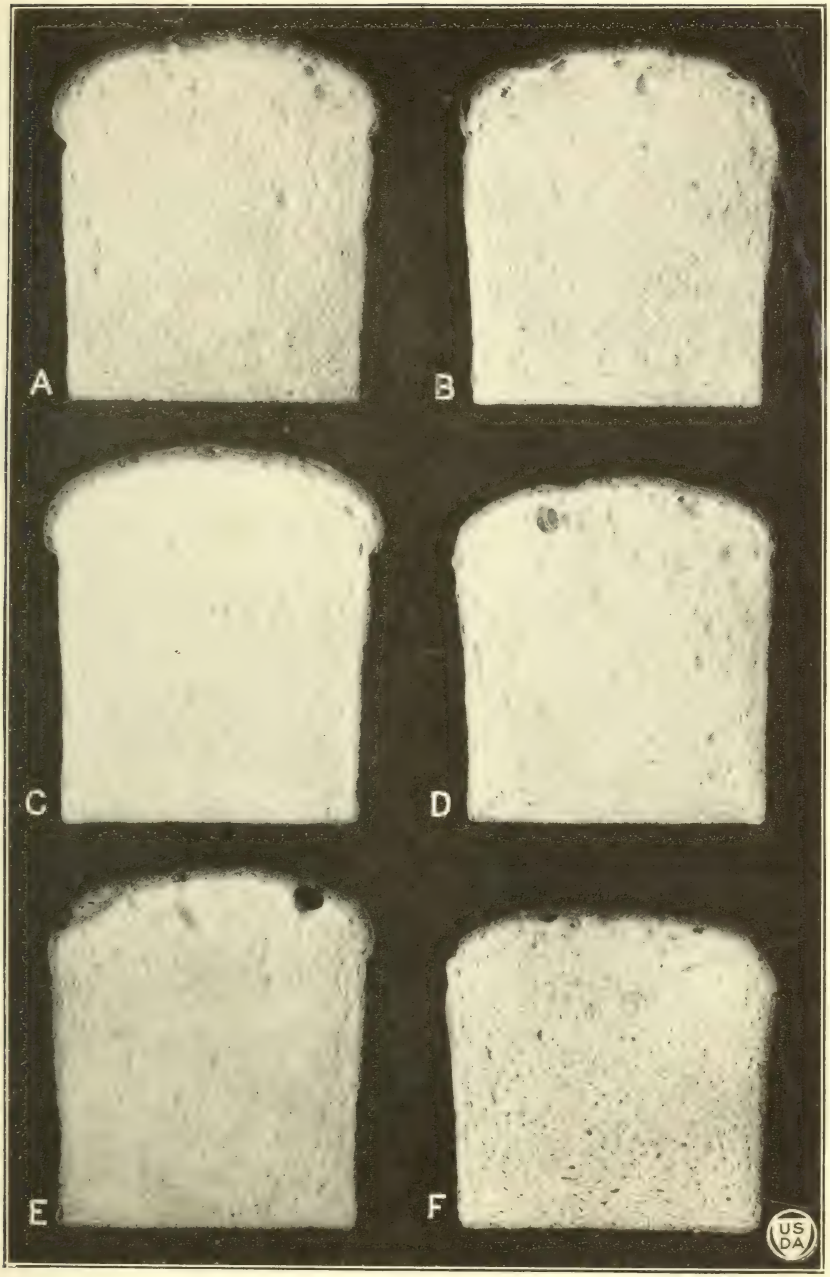
TABLE 11.—*Summary of milling and baking data on 12 samples of Chul and 12 comparable samples of Marquis grown during the four years from 1917 to 1919, inclusive, and in 1921.*

Descriptive data.	Chul.	Marquis.	Percentage of Marquis.
Number of samples	12	12	.....
Test weight per bushel (mill-cleaned wheat).....pounds..	59.3	59.4	99.8
Crude protein content of wheat.....per cent..	14.0	14.5	96.6
Yield of straight flour.....do....	71.4	71.7	99.6
Yield of shorts.....do....	15.3	15.1	101.3
Yield of bran.....do....	13.3	13.2	100.8
Water absorption of flour.....do....	61.2	59.8	102.3
Volume of loaf.....cubic centimeters..	1,954	2,290	85.3
Weight of loaf.....grams..	501	494	101.4
Texture of loaf.....score..	90.0	91.3	98.6
Color of loaf.....do....	91.9	92.0	99.9
Ash in flour [1].....per cent..	0.48	0.49	98.0

[1] Average of eight samples.

Dakota.—The Dakota variety is a pure-line selection of the original Haynes Bluestem wheat and was developed at the North Dakota Agricultural Experiment Station about 1898. It was widely grown in North Dakota about a decade ago, but because of its late maturity and consequent injury from rust and drought the Dakota variety usually produces low yields, and has been largely displaced by Marquis.

The samples of the Dakota wheat which were milled and baked were obtained mostly from commercial sources in 1916, the year of a severe rust epidemic. This accounts for its low test weight per bushel. The results show that it is very similar in quality to the



LOAVES OF BREAD FROM SIX VARIETIES OF HARD RED SPRING WHEAT.

The varieties, with source of grain and average loaf volumes, are as follows: From Dickinson, N. Dak., 1920 crop: *A*, Marquis, 2,320 c. c.; *B*, Kota, 2,250 c. c ; *C*, Red Fife, 2,290 c. c.; *D*, Haynes Bluestem, 2,110 c. c.; *E*, Preston, 2,190 c. c.; from Hoffman, Minn., 1918 crop: *F*, Humpback, 1,830 c. c.

Haynes Bluestem wheat described later, and resembles it in the appearance of the plant and grain.

Ghirka.—The Ghirka variety, known also as Early Russian, Russian, and Russian Fife, was introduced from the Volga River district of southern Russia by the United States Department of Agriculture and also by Russian immigrants. Ghirka is awnless and has glabrous, white glumes. It resembles the Fife wheats but has larger and softer kernels and more tapering heads. The variety is grown sparingly, mostly under the name of Russian, in western North Dakota, South Dakota, and in Wyoming.

Forty-three samples of Ghirka wheat have been milled from samples obtained from experiment stations in Colorado, North Dakota, Minnesota, Montana, Nebraska, Texas, and Wyoming during the six years from 1915 to 1920, inclusive. Comparable samples of Marquis are available for comparison with 34 of the Ghirka samples. A summary of the results from these samples is shown in Table 12.

The data show that the Ghirka variety is inferior to Marquis in both milling and baking qualities, and is especially inferior in yield of straight flour produced. The acre yields of Ghirka have been lower than Marquis, hence its cultivation should be discontinued.

TABLE 12.—*Summary of milling and baking data on 34 samples of Ghirka and 34 comparative samples of Marquis grown during the six years from 1915 to 1920, inclusive.*

Descriptive data.	Ghirka.	Marquis.	Percentage of Marquis.
Number of samples	34	34	
Test weight per bushel (mill-cleaned wheat)...pounds	58.4	59.2	98.6
Crude protein content of wheat...per cent	14.2	15.3	92.8
Yield of straight flour...do	66.4	69.5	95.5
Yield of shorts...do	18.2	17.6	103.4
Yield of bran...do	15.4	12.9	119.4
Water absorption of flour...do	60.4	60.6	99.7
Volume of loaf...cubic centimeters	2,109	2,336	90.3
Weight of loaf...grams	496	497	99.8
Texture of loaf...score	86.2	91.4	94.3
Color of loaf...do	88.2	93.2	94.6
Ash in flour [1]...per cent	0.46	0.50	92.0

[1] Average of eight samples.

Glyndon.—The Glyndon variety, known also as Minnesota No. 163, is a pure strain of Fife wheat originated at the Minnesota Agricultural Experiment Station. It is an awnless, glabrous, white-glumed variety similar to Red Fife. It was first distributed for commercial growing in 1898 and soon became one of the most important wheats grown in Minnesota, but in recent years it has largely disappeared from cultivation.

In all, 36 samples of Glyndon wheat have been milled, all of which can be directly compared with samples of Marquis grown under similar conditions. These samples were obtained from experiment stations in Minnesota, North Dakota, South Dakota, Montana, Wyoming, Colorado, Nebraska, and Texas during the seven-year period from 1915 to 1921, inclusive. A summary of the results of the comparable tests with Glyndon and Marquis are shown in Table 13.

The experiments show that Glyndon slightly exceeds Marquis in percentage of crude protein, but is inferior to Marquis in all other factors with the exception that it has a lower ash content of flour.

Glyndon is shown to be considerably inferior to Marquis in volume of loaf, the principal bread-making factor. It is inferior to Marquis in yield, and should be displaced by that variety.

TABLE 13.—*Summary of milling and baking data on 36 samples of Glyndon and 36 comparable samples of Marquis grown during the seven years from 1915 to 1921, inclusive.*

Descriptive data.	Glyndon.	Marquis.	Percentage of Marquis.
Number of samples	36	36	
Test weight per bushel (mill-cleaned wheat)...pounds..	57.9	59.3	97.6
Crude protein content of wheat...per cent..	15.5	15.3	101.3
Yield of straight flour...do....	69.5	70.1	99.1
Yield of shorts...do....	15.8	16.8	94.0
Yield of bran...do....	14.7	13.1	112.2
Water absorption of flour...do....	60.3	60.9	99.0
Volume of loaf...cubic centimeters..	2,137	2,352	90.9
Weight of flour...grams..	494	497	99.4
Texture of loaf...score..	88.1	91.4	96.4
Color of loaf...do....	89.1	93.1	95.7
Ash in flour [1]...per cent..	0.47	0.50	94.0

[1] Average of 10 samples.

Haynes Bluestem.—The Haynes Bluestem variety, known also as Bluestem, Marvel Bluestem, and Minnesota No. 169, was first developed through selection by L. H. Haynes, of Fargo, N. Dak., about 1895. Bluestem wheat was grown in the Dakotas, however, before Mr. Haynes distributed his strain. The variety was further selected by the Minnesota Agricultural Experiment Station, which distributed a pure-line selection known as Minnesota 169, in the late nineties. The name Haynes Bluestem is now commonly used for the several strains that have been developed and grown. It is an awnless, pubescent (velvety), white-glumed wheat, that matures late and is frequently injured by rust and drought.

In all, 128 samples of Haynes Bluestem wheat have been milled. Fifty-four of these can be directly compared with samples of Marquis grown under the same conditions. Many commercial samples of Bluestem wheat were obtained from farmers, elevators, and milling companies in the Dakotas and Montana. The samples that can be compared with Marquis were obtained from the experiment stations in North Dakota, South Dakota, Minnesota, Montana, Wyoming, Nebraska, and Texas during the seven years from 1915 to 1921, inclusive. A summary of the comparable samples and those of Marquis are shown in Table 14.

The data show Haynes Bluestem to have a lighter test weight per bushel than the samples of Marquis grown under similar conditions. This is in part due to its great susceptibility to stem rust. In crude protein the Haynes Blustem slightly exceeds Marquis, as it does in water absorption of flour. In yield of straight flour and in volume, texture, and color of loaf it is inferior to Marquis. Flour from Haynes Bluestem has averaged higher in ash than that from Marquis. Haynes Bluestem has produced lower yields than most other varieties of hard red spring wheat, due largely to its late maturity. Considering all these facts it would be advisable to discontinue Haynes Bluestem from cultivation.

TABLE 14.—*Summary of milling and baking data on 54 samples of Haynes Bluestem and 54 comparable samples of Marquis grown during the seven years from 1915 to 1921, inclusive.*

Descriptive data.	Haynes Bluestem.	Marquis.	Percentage of Marquis.
Number of samples	54	54	.....
Test weight per bushel (mill-cleaned wheat) ..... pounds	56.6	59.2	95.6
Crude protein content of wheat ..... per cent	15.6	15.5	100.6
Yield of straight flour ..... do	70.1	70.3	99.7
Yield of shorts ..... do	14.8	15.7	94.3
Yield of bran ..... do	15.1	14.0	107.9
Water absorption of flour ..... do	61.3	60.8	100.8
Volume of loaf ..... cubic centimeters	2,228	2,354	94.6
Weight of loaf ..... grams	498	498	100.0
Texture of loaf ..... score	90.0	91.1	98.8
Color of loaf ..... do	90.2	92.8	97.2
Ash in flour [1] ..... per cent	0.50	0.48	104.2

[1] Average of 28 samples.

Humpback.—The Humpback variety originated from field selections made by J. P. Berglund, a farmer living near Kensington, Minn. The original head was probably the result of natural hybridization. Two strains were developed, the first being distributed about 1905. This strain is often called Bearded Bluestem, as the head is bearded and has pubescent or velvety chaff (glumes). A second strain, having glabrous or smooth chaff, was distributed somewhat later than the first, and both strains were grown as Humpback. The second strain has recently been named Dixon. In recent years the acreage of both strains has been reduced, principally because of their poor milling and baking quality. In 1919 it was estimated that about 32,000 acres of both strains were grown in Illinois, Minnesota, Nebraska, North Dakota, South Dakota, and Wisconsin. Since that year the acreage is believed to have been still further reduced.

Sixty-two samples of the so-called Humpback wheat have been milled. These were obtained almost entirely from commercial sources in Minnesota, South Dakota, and North Dakota, where the variety was principally grown. No distinction was made between the two strains when most of these samples were obtained, and it is therefore not possible to present the results from the varieties separately. There are also few samples of Marquis grown under conditions which would make it possible to give a fair comparison between Humpback and that variety. The data given in Table 9, however, show that the Humpback variety produces a high percentage of straight flour but is exceptionally low in crude protein content, water absorption, and loaf volume, as well as in color and texture of the bread. These experiments confirm the results obtained from commercial mills which early showed Humpback to be poorly adapted to the manufacture of bread-making flour. Because of its inferior bread-making qualities, the requirements of the Federal wheat standards for hard red spring wheat places it in the red spring subclass.

In addition to its poor bread-making quality, Humpback wheat has produced low yields in nearly all comparative experiments. The growing of this variety should be discontinued.

Kitchener.—Kitchener originated from a distinctly different head of wheat found in a field of Marquis in 1911 by Dr. Seager Wheeler at Maple Grove Farm, Rosthern, Saskatchewan, Canada. This wheat, which is distinctly different from Marquis, was increased and distributed about four or five years later. Kitchener wheat is grown to some extent in Canada but is not yet important in the United States. It differs from Marquis in being taller and later and in having a wider or more clavate spike.

Nine samples of Kitchener wheat have been milled. These were obtained from experiment stations in Minnesota, North Dakota, Montana, Wyoming, and Colorado, where they were grown in 1918, 1920, and 1921. Eight of these samples are directly comparable with samples of the Marquis variety grown at the same points and under similar conditions. The results of these comparable tests are shown in Table 15.

The data show that Kitchener is equal in yield of straight flour to Marquis, but inferior in test weight per bushel and in volume and color of loaf. The differences are not great except in volume of loaf, where it appears to be significantly poorer than Marquis. In general, Kitchener is a very satisfactory milling and bread-making wheat.

Kitchener wheat has yielded somewhat less than Marquis in comparative experiments.

TABLE 15.—*Summary of milling and baking data on eight samples of Kitchener and eight comparable samples of Marquis grown in the three years 1918, 1919, and 1921.*

Descriptive data.	Kitchener.	Marquis.	Percentage of Marquis.
Number of samples	8	8	
Test weight per pushel (mill-cleaned wheat)....pounds..	58.5	59.9	97.7
Crude protein content of wheat....per cent..	14.1	15.3	92.2
Yield of straight flour....do....	71.1	71.1	100.0
Yield of shorts....do....	14.3	13.9	102.9
Yield of bran....do....	14.6	15.0	97.3
Water absorption of flour....do....	60.6	60.6	100.0
Volume of loaf....cubic centimeters..	2,184	2,300	95.0
Weight of loaf....grams..	504	500	100.8
Texture of loaf....score..	89.6	89.1	100.6
Color of loaf....do....	90.6	92.1	98.4
Ash in flour....per cent..	0.49	0.50	98.0

Kota.—The original seed of this variety was obtained in Russia, in 1903, by Prof. H. L. Bolley, of the North Dakota Agricultural College, while making a study of the flax industry of Europe for the United States Department of Agriculture. In the years immediately following its introduction this wheat was not known to have any special merit. After the rust epidemic of 1916 mixtures of it in Monad durum wheat were found, by L. R. Waldron,[6] of the North Dakota Agricultural Experiment Station, and J. A. Clark, of the United States Department of Agriculture, to be resistant to some forms of stem rust. They separated it from Monad, found it to have good agronomic and milling values, and named it Kota. The commercial production of Kota wheat began in 1919, and in 1922 about

[6] Waldron, L. R., and Clark, J. A.: Kota, a rust-resisting variety of common spring wheat. In Jour. Amer. Soc. Agron., v. 11, No. 5, p. 187-195, 1919.

6,000 acres of the variety were grown. Kota is awned and has glabrous white glumes. Its kernels are larger and harder than most other varieties of hard red spring wheat.

In all, 38 milling tests have been made with Kota wheat. Samples were obtained from experiment stations in North Dakota, South Dakota, Minnesota, Montana, Wyoming, Colorado, Nebraska, Kansas, Wisconsin, Oregon, and Washington. Most of the samples were from the 1921 crop, only 9 samples having been milled from samples grown during the three years 1918 to 1920. Of the 38 samples, 33 are directly comparable with samples of Marquis. Data on these samples are shown in Table 16.

Partly because Kota is resistant to stem rust, it has averaged heavier in test weight per bushel and therefore has graded higher than samples of Marquis grown under the same conditions. In these experiments it has averaged higher than Marquis in yield of flour and shorts, but lower in bran. It is higher in crude protein and water absorption and slightly higher in weight and texture of loaf. On the average it has given a lower loaf volume than Marquis but a higher volume than the other commercial varieties of hard red spring wheat. It has scored lower in color of bread and has a considerably higher ash content. In general, however, Kota has proven superior to Marquis in 7 of the 11 important milling and baking factors, the unweighted average of which shows Kota to exceed Marquis and all other commercial varieties of hard red spring wheat in milling and bread-making values. The production of this variety has increased rapidly since its value was discovered, and it doubtless will soon become one of the most important varieties of hard red spring wheat.

The yields per acre of Kota have averaged considerably higher than Marquis in North Dakota and South Dakota during the past four years and it has produced good yields in northeastern portions of Montana, Wyoming, and Colorado. Outside of these regions it usually has yielded less than Marquis.

TABLE 16.—*Summary of milling and baking data on 33 samples of Kota and 33 comparable samples of Marquis grown during the four years from 1918 to 1921, inclusive.*

Descriptive data.	Kota.	Marquis.	Percentage of Marquis.
Number of samples	33	33	
Test weight per bushel (mill-cleaned wheat).....pounds..	60.4	57.8	104.5
Crude protein content of wheat.....per cent..	15.6	15.0	104.0
Yield of straight flour.....do....	70.8	69.0	102.6
Yield of shorts.....do....	15.0	14.3	104.9
Yield of bran.....do....	14.2	16.7	85.0
Water absorption of flour.....do....	64.4	60.2	107.0
Volume of loaf.....cubic centimeters..	2,263	2,380	95.1
Weight of loaf.....grams..	506	497	101.8
Texture of loaf.....score..	90.8	89.4	101.6
Color of loaf.....do....	88.6	90.8	97.6
Ash in flour[1].....per cent..	0.60	0.53	113.2

[1] Average of 32 samples.

Marquis.—The Marquis variety was originated in Canada by selection from a hybrid produced by crossing Red Fife with a hard red

wheat from Calcutta, India. The cross was made by Dr. A. P. Saunders, of the Dominion department of agriculture, about 1892, and the plant from which Marquis developed was selected in 1903 by Dr. C. E. Saunders, Dominion cerealist, who named the variety. The commercial growing of Marquis wheat began in Canada about 1909 and in the United States about 1913. It soon became the leading spring wheat in North America. More than 11 million acres of Marquis were grown in the United States in 1919.

Marquis has produced the highest average yields of any hard red spring variety in nearly all areas where this class of wheat is grown. Red Fife and Power yield as well as Marquis in northwestern North Dakota and northeastern Montana. Kota outyields Marquis in North and South Dakota in seasons when rust occurs. Java (Early Java) or selections from it have yielded as well as Marquis in central Iowa and northern Wisconsin. Red Bobs appears to outyield Marquis in central Montana. With the exceptions mentioned above, Marquis is the most productive variety of hard red spring wheat and is well adapted to all of the northern spring wheat region. It is not resistant to rust. On poor soils it is not especially productive and sometimes is too short to be harvested readily.

When grown under favorable conditions Marquis produces a plump kernel that yields a good percentage of flour. Well-developed Marquis kernels are equal or superior to all other hard red spring wheats in yield of flour. Under unfavorable conditions Marquis may have a lower test weight per bushel and consequently a lower flour yield than some other varieties. In the quality of its flour for bread making Marquis excels all other varieties of hard red spring wheat now commercially grown in the United States. The bread produced from this wheat has a large expansion and an excellent texture and color. The milling and baking data from all samples of Marquis are shown in Table 9, and the data from samples comparable with each other variety of hard red spring wheat are shown in Tables 11 to 24, inclusive, in connection with the discussion of these other varieties.

Norka.—Norka originated from a pure-line selection of a common wheat separated from a plat of Kubanka durum in 1908, by W. G. Shelley, then a representative of the United States Department of Agriculture at Akron, Colo. The name is the reverse spelling of Akron. It is an awned, glabrous, brown-glumed wheat with hard, bright red kernels. This variety showed considerable promise as a high-yielding spring wheat at Akron and was further tested at experiment stations in Wyoming, Montana, and North Dakota, from which nine milling samples were obtained in 1918, 1920, and 1921. All samples milled can be directly compared with those of Marquis, and the comparison is shown in Table 17.

The results show that while Norka exceeded Marquis in test weight per bushel, crude protein content, and yield of flour and shorts, it produced a very low loaf volume, is considerably inferior in color of loaf, and is high in ash content. As the experiments proved the variety to be of low bread-making value, and as it has given only medium yields, it was not distributed commercially and is now discarded from experiments at most stations.

TABLE 17.—*Summary of milling and baking data on nine samples of Norka and nine comparable samples of Marquis grown during the three years 1918, 1920, and 1921.*

Descriptive data.	Norka.	Marquis.	Percentage of Marquis.
Number of samples	9	9	
Test weight per bushel (mill-cleaned wheat)....pounds..	61.2	59.4	103.0
Crude protein content of wheat....per cent..	16.4	15.0	109.3
Yield of straight flour....do....	71.8	69.7	103.0
Yield of shorts....do....	16.1	15.0	107.3
Yield of bran....do....	12.1	15.3	79.1
Water absorption of flour....do....	60.8	61.1	99.5
Volume of loaf....cubic centimeters..	1,824	2,329	78.3
Weight of loaf....grams..	502	500	100.4
Texture of loaf....score...	88.8	89.3	99.4
Color of loaf....do....	87.3	92.3	94.6
Ash in flour....per cent..	0.54	0.47	114.9

Pioneer.—Pioneer wheat was obtained from a cross between Riga and Preston made by Dr. C. E. Saunders in 1903 at the Central Experimental Farm, Ottawa, Canada. It is an early bearded variety with glabrous white glumes. This variety was introduced into the United States for experimental purposes by the United States Department of Agriculture in 1915. It has since been grown at a considerable number of experiment stations, but as it has not exceeded Marquis in yield it has not been distributed for commercial growing in the United States, although it is grown commercially to a limited extent in Canada.

Sixty samples of Pioneer have been tested for their milling and bread-making value. Samples were obtained from experiment stations in North Dakota, South Dakota, Minnesota, Montana, Wyoming, Colorado, Nebraska, and Texas. Fifty-six samples can be directly compared with samples of Marquis grown under the same conditions. A summary of the comparative results of these experiments is shown in Table 18.

The data show Pioneer to equal or slightly exceed Marquis in all milling and baking factors except volume, weight, and texture of loaf, and in these factors it is not significantly poorer. In general, Pioneer is about equal to Marquis in milling and bread-making value.

TABLE 18.—*Summary of milling and baking data on 56 samples of Pioneer and 56 comparable samples of Marquis grown during the seven years from 1915 to 1921, inclusive.*

Descriptive data.	Pioneer.	Marquis.	Percentage of Marquis.
Number of samples	56	56	
Test weight per bushel (mill-cleaned wheat)....pounds..	58.9	58.2	101.2
Crude protein content of wheat....per cent..	16.2	15.5	104.5
Yield of straight flour....do....	70.9	69.6	101.9
Yield of shorts....do....	16.5	16.6	99.4
Yield of bran....do....	12.6	13.8	91.3
Water absorption of flour....do....	60.7	60.7	100.0
Volume of loaf....cubic centimeters..	2,320	2,347	98.8
Weight of loaf....grams..	495	498	99.4
Texture of loaf....score..	90.6	91.2	99.3
Color of loaf....do....	90.9	90.4	100.6
Ash in flour[1]....per cent..	0.49	0.49	100.0

[1] Average of 26 samples.

Power.—Power wheat is nearly identical with Red Fife, although the heads and kernels are shorter, and in this respect is very similar

to Marquis. It has awnless spikes and glabrous or smooth white glumes. The original Power Fife was developed from a single plant found growing in an oat field by James Holes, at Fargo, N. Dak., about 1895. The North Dakota Agricultural Experiment Station, which grew this wheat under the designation of Station No. 66, made some selections from it and distributed one of them from the Williston substation as Power or North Dakota No. 313, which is the origin of most of the variety now grown. This variety is commercially grown only in North Dakota and Montana.

Sixty-two samples of the Power variety have been milled, fifty-nine of which are directly comparable with samples of Marquis grown under the same conditions. The samples were nearly all obtained from the experiment stations in North Dakota, South Dakota, Montana, Wyoming, Nebraska, Colorado, and Texas during the seven years from 1915 to 1921, inclusive. A summary of the comparable experiments is shown in Table 19.

Experiments show Power to be slightly superior to Marquis in crude protein, yield of flour, and water absorption. In volume and color of loaf, however, it is significantly poorer than Marquis. The milling qualities of Power have proved to be similar to other strains of Fife wheat, such as Glyndon and Red Fife, all of which are somewhat inferior to Marquis in the important bread-making factors.

Power has yielded less than Marquis in all sections except in northeastern Montana and northwestern North Dakota, where it yields about as well as Marquis.

TABLE 19.—*Summary of milling and baking data on 59 samples of Power and 59 comparable samples of Marquis grown during the seven years from 1915 to 1921, inclusive.*

Descriptive data.	Power.	Marquis.	Percentage of Marquis.
Number of samples	59	59	
Test weight per bushel (mill-cleaned wheat)...pounds..	58.8	58.7	100.2
Crude protein content of wheat...per cent..	16.0	15.7	101.9
Yield of straight flour...do....	70.8	69.9	101.3
Yield of shorts...do....	15.0	15.9	94.3
Yield of bran...do....	14.2	14.2	100.0
Water absorption of flour...do....	61.3	60.8	100.8
Volume of loaf...cubic centimeters..	2,123	2,351	90.3
Weight of loaf...grams..	500	498	100.4
Texture of loaf...score..	88.0	90.8	96.9
Color of loaf...do....	89.4	92.5	96.6
Ash in flour [1]...per cent..	0.47	0.48	97.9

[1] Average of 32 samples.

Prelude.—Prelude was originated by Dr. C. E. Saunders, cerealist of the Dominion department of agriculture, at the Central Experimental Farm, Ottawa, Canada. It is an extremely early wheat with awned spikes, and pubescent white or yellowish glumes. It was first distributed in Canada in 1913, and was introduced into the United States by the United States Department of Agriculture for experimental purposes in 1915. It is grown to a limited extent in Wisconsin and Minnesota, principally under the name Wisconsin Wonder.

Fifty-eight milling tests have been made of the Prelude variety, the results of which are shown in Table 9. Fifty-three of these

tests are comparable with samples of Marquis produced under the same conditions. The results of these experiments are shown in Table 20. The samples were all obtained from experiment stations in the spring wheat area from which samples of Pioneer were obtained.

The data show Prelude to exceed Marquis in the milling factors and to be only slightly inferior to it in baking factors. It has a much higher percentage of crude protein than Marquis and most of the other varieties of hard red spring wheat. It also has a higher flour yield than Marquis. It averages considerably higher in ash content of straight flour. In general, however, Prelude is nearly equal in milling and bread-making value to Marquis. On the average Prelude has yielded less than Marquis in all sections where spring wheat is well adapted.

Prelude should not be grown in this country. In the Great Plains section of Colorado and Nebraska, where winter wheat usually is grown, Prelude yields more than Marquis in unfavorable seasons, but even then its yields are rather low. Prelude is best adapted to the northern wheat growing sections of Canada where seasons are short.

TABLE 20.—*Summary of milling and baking data on 53 samples of Prelude and 53 comparable samples of Marquis grown during the seven years from 1915 to 1921, inclusive.*

Descriptive data.	Prelude.	Marquis.	Percentage of Marquis.
Number of samples	53	53	
Test weight per bushel (mill-cleaned wheat)....pounds..	59.6	58.2	102.4
Crude protein content of wheat....per cent..	16.6	15.3	108.5
Yield of straight flour....do....	72.4	69.6	104.0
Yield of shorts....do....	15.1	16.4	92.3
Yield of bran....do....	12.5	14.0	89.1
Water absorption of flour....do....	59.9	60.4	99.2
Volume of loaf....cubic centimeters..	2,287	2,345	97.5
Weight of loaf....grams..	496	497	99.8
Texture of loaf....score..	87.8	91.0	96.5
Color of loaf [1]....do....	88.1	91.6	96.2
Ash in flour [2]....per cent..	0.52	0.49	106.1

[1] Average of 49 samples. [2] Average of 24 samples.

Preston.—Preston wheat, known principally as Velvet Chaff, and also as Bearded Fife, Blue Ribbon, Climax, Golden Drop, Johnson, and Minnesota No. 188, is of somewhat uncertain origin. It is an awned, glabrous, white-glumed wheat. The true Preston variety was developed from a cross between Ladoga and Red Fife, made by Dr. William Saunders, of the Central Experimental Farm, Ottawa, Canada, in 1888. It is thought that most of the wheat grown in the northern spring wheat section as Velvet Chaff is true Preston, although some of it may be of earlier origin. It was estimated that 2,233,000 acres were grown in the United States in 1919. Sections of its heaviest production are in the Red River and Minnesota River Valleys of Minnesota.

In all, 119 samples of Preston wheat have been milled and baked. Many of these samples are of commercial origin, coming from farms and elevators throughout the spring-wheat section. The average results from all samples are shown in Table 9. Sixty-nine of the samples can be compared with samples of Marquis grown under similar con-

ditions, and these comparable data are shown in Table 21. These latter samples were obtained from the various experiment stations in North Dakota, South Dakota, Minnesota, Montana, Wyoming, Colorado, Nebraska, and Texas during the seven years from 1915 to 1921, inclusive.

The data show the Preston variety to have a high weight per bushel, and to be practically equal to Marquis in flour yield. It is only slightly inferior to Marquis in water absorption, crude protein content, and in the weight, color, and texture of loaf, but is considerably inferior in loaf volume. While slightly inferior to Marquis in these experiments, Preston has not proved to be as poor a milling wheat as is commonly claimed by many commercial millers.

Preston or Velvet Chaff has produced considerably lower yields per acre than Marquis in all districts where grown except in the Minnesota River and Red River Valleys, where it yields only slightly less than Marquis. The area now devoted to the growing of Preston wheat should be sown with Marquis.

TABLE 21.—*Summary of milling and baking data on 69 samples of Preston and 69 comparable samples of Marquis grown during the seven years from 1915 to 1921, inclusive.*

Descriptive data.	Preston.	Marquis.	Percentage of Marquis.
Number of samples	69	69	.....
Test weight per bushel (mill-cleaned wheat).....pounds..	59.3	58.4	101.5
Crude protein content of wheat.....per cent..	15.4	15.5	99.4
Yield of straight flour.....do....	69.6	69.6	100.0
Yield of shorts.....do....	15.5	16.2	95.7
Yield of bran.....do....	14.9	14.2	104 9
Water absorption of flour.....do....	60.3	60.7	99.3
Volume of loaf.....cubic centimeters..	2,212	2,348	94.2
Weight of loaf.....grams..	496	498	99.6
Texture of loaf.....score..	89.0	90.8	98.0
Color of loaf.....do....	89.7	92.0	97.5
Ash in flour [1].....per cent..	0.49	0.50	98.0

[1] Average of 39 samples.

Red Bobs.—Red Bobs originated from a head found in a field of Bobs, a white wheat, in 1910, by Dr. Seager Wheeler, of Rosthern, Saskatchewan, Canada. It is probably the result of a natural field hybrid between Bobs and Marquis. It is an early maturing, awnless, glabrous, white-glumed variety. It was first distributed in 1918, and has since been considerably grown in Canada, and probably to a limited extent commercially in the United States. It has been grown in experiments in the United States since 1920.

Twenty samples of the variety have been milled and baked, 19 of which are directly comparable with samples of Marquis grown under the same conditions. The samples were obtained from experiment stations in North Dakota, Minnesota, Montana, Colorado, Nebraska, Oregon, and Washington, and represent two crop years, 1920 and 1921. A summary of the results with Marquis and Red Bobs is shown in Table 22.

Experiments show Red Bobs to be slightly lower than Marquis in test weight per bushel and crude protein, but considerably superior to Marquis in yield of flour and slightly superior in water absorption. It is only slightly inferior to Marquis in loaf volume, in that respect ranking second among the varieties of hard red spring. It has about equal weight and texture of loaf, but has scored somewhat

lower in color. Flour from Red Bobs has the added advantage of being somewhat lower in ash content than that from Marquis. In all respects Red Bobs is a first-class milling and bread-making wheat.

Red Bobs is very susceptible to rust and partly for this reason should not be grown in the Dakotas or Minnesota. It has produced rather promising yields in central Montana, however.

TABLE 22.—*Summary of milling and baking data on 19 samples of Red Bobs and 19 comparable samples of Marquis grown during the two years 1920 and 1921.*

Descriptive data.	Red Bobs.	Marquis.	Percentage of Marquis.
Number of samples	19	19	.....
Test weight per bushel (mill-cleaned wheat).....pounds..	57.2	58.7	97.4
Crude protein content of wheat.....per cent..	14.4	15.0	96.0
Yield of straight flour.....do....	71.5	69.8	102.4
Yield of shorts.....do....	13.5	14.8	91.2
Yield of bran.....do....	15.0	15.4	97.4
Water absorption of flour.....do....	60.3	60.2	100.2
Volume of loaf.....cubic centimeters..	2,238	2,292	97.6
Weight of loaf.....grams..	498	499	99.8
Texture of loaf.....score..	89.6	89.1	100.6
Color of loaf.....do....	90.8	91.9	98.8
Ash in flour.....per cent..	0.49	0.51	96.1

Red Fife.—The original Red Fife wheat is supposed to have come from Poland or Russia by way of Germany, Scotland, and Canada. It became commercially established in the spring-wheat sections of the United States in the early eighties. The name Red Fife is commonly used for the variety in Canada, but in the United States it is better known as Fife or Scotch Fife. Several similar strains have been selected from the original Fife wheat, principal of which are Power and Glyndon, previously discussed. Red Fife was formerly one of the principal varieties of hard red spring wheat, but has now been replaced largely by Marquis. In 1919 it was estimated that the combined area sown to Red Fife, Glyndon, and Power amounted to 350,000 acres. Since that year, however, the acreage is thought to have been still further reduced. Red Fife has awnless spikes and glabrous or smooth white glumes. It is somewhat taller and later than Marquis.

Thirty-four samples of Red Fife wheat have been milled, most of which were commercial samples obtained from farms or elevators throughout North Dakota and Minnesota. The results of these experiments are shown in Table 9. Only five of the samples can be directly compared with samples of Marquis grown under the same conditions. These results are summarized in Table 23. The data show the Red Fife variety to be nearly equal to the Marquis variety in all factors except volume of loaf and in ash content of flour. In loaf volume it is significantly lower, which is a decided disadvantage. In ash content of straight flour it is also considerably lower, which, however, is an advantage.

The Red Fife, as well as the similar varieties Power and Glyndon, are very good milling hard red spring wheats, but all are significantly exceeded by Marquis in volume of loaf. Red Fife on the average produces lower acre yields than Marquis, except in northwestern North Dakota and northeastern Montana.

TABLE 23.—*Summary of milling and baking data on five samples of Red Fife and five comparable samples of Marquis grown during the five years 1915 and 1918 to 1921, inclusive.*

Descriptive data.	Red Fife.	Marquis.	Percentage of Marquis.
Number of samples	5	5	
Test weight per bushel (mill-cleaned wheat).....pounds..	59.3	60.4	98.2
Crude protein content of wheat.....per cent..	15.7	15.8	99.4
Yield of straight flour.....do....	70.6	69.9	101.0
Yield of shorts.....do....	14.8	14.7	100.7
Yield of bran.....do....	14.6	15.4	94.8
Water absorption of flour.....do....	60.1	59.9	100.3
Volume of loaf.....cubic centimeters..	2,361	2,613	90.4
Weight of loaf.....grams..	500	496	100.8
Texture of loaf.....score..	93.3	92.7	100.6
Color of loaf.....do....	94.2	95.2	98.9
Ash in flour[1].....per cent..	0.40	0.44	90.9

[1] Average of 4 samples.

Ruby.—Ruby wheat was originated by Dr. C. E. Saunders, Dominion cerealist, at the Central Experimental Farm, Ottawa, Canada. It is the result of a cross between Red Fife and a hybrid wheat known as Downy Riga. It was first distributed for commercial growing in 1917. It has been grown in experiments in the United States since 1918 and commercially in North Dakota since 1920. A considerable acreage of the variety is now grown in that State. It is an early maturing, awnless, glabrous white-glumed variety.

Twenty-two milling tests of the Ruby variety have been made from samples obtained from experiments in North Dakota, Minnesota, Montana, Wyoming, and Colorado during one or more of the three years 1918, 1920, and 1921. Twenty-one of the samples can be directly compared with samples of Marquis grown under similar conditions. These results are shown in Table 24.

These experiments show Ruby to be slightly heavier than Marquis in test weight per bushel and to average considerably higher in crude protein. It has equaled Marquis in yield of flour and has yielded considerably more shorts and less bran. It is considerably higher than Marquis in water absorption, but has produced a considerably smaller loaf. In weight, color, and texture of loaf, however, it is superior to Marquis. The flour produced from Ruby variety has a somewhat higher ash content than that from Marquis, which is a disadvantage. In general, the Ruby is a first-class milling and bread-making wheat.

In yield of grain per acre Ruby is inferior to Marquis except under unfavorable conditions, when the earliness of Ruby enables it to partially escape injury from rust and drought.

TABLE 24.—*Summary of milling and baking data on 21 samples of Ruby and 21 comparable samples of Marquis grown during the four years from 1918 to 1921, inclusive.*

Descriptive data.	Ruby.	Marquis.	Percentage of Marquis.
Number of samples	21	21	
Test weight per bushel (mill-cleaned wheat).....pounds..	59.5	58.7	101.4
Crude protein content of wheat.....per cent..	15.4	14.9	103.4
Yield of straight flour.....do....	70.0	69.9	100.1
Yield of shorts.....do....	15.6	14.7	106.1
Yield of bran.....do....	14.4	15.4	93.5
Water absorption of flour.....do....	62.6	60.6	103.3

TABLE 24.—*Summary of milling and baking data on 21 samples of Ruby and 21 comparable samples of Marquis grown during the four years from 1918 to 1921, inclusive*—Continued.

Descriptive data.	Ruby.	Marquis.	Percentage of Marquis.
Volume of loaf.....cubic centimeters..	2,195	2,300	95.4
Weight of loaf.....grams..	506	500	101.2
Texture of loaf.....score..	89.2	88.9	100.3
Color of loaf.....do....	92.8	91.6	101.3
Ash in flour[1].....per cent..	0.52	0.49	106.1

[1] Average of 20 samples.

SUMMARY OF MILLING AND BAKING DATA ON THE VARIETIES OF HARD RED SPRING WHEAT.

Table 25 and Figure 3 give a summary of the milling and baking data on 15 varieties of hard red spring wheat expressed in percentages of the average data of the comparable samples of Marquis. The percentages given are those shown for each variety in Tables 11 to 24, inclusive.

In volume of loaf, the principal factor in bread-making quality, Marquis excels all other varieties. In yield of straight flour, the most important milling factor, Marquis is exceeded by eight varieties. Prelude, Norka, and Kota, in the order named, show the highest flour yields. In crude protein, Norka, Prelude, Pioneer, Kota, and Ruby show the highest comparative crude protein content, and the same varieties are among the highest in test weight per bushel. Only two varieties exceeded Marquis in color of loaf and five varieties in texture of loaf. Norka, Kota, Prelude, and Ruby show relatively high ash content of flour, which is disadvantageous. Considering all milling and baking factors, Marquis is without doubt the best variety. Prelude, Pioneer, Ruby, and Kota, however, are only slightly inferior to Marquis and are closely followed by the varieties Kitchener, Red Fife, Glyndon, Haynes Bluestem, Power, and Preston. The varieties Chul, Norka, and Ghirka are not suitable for the making of bread of high quality.

TABLE 25.—*Summary of milling and baking data, in percentage of Marquis, on comparable samples of 14 other varieties of hard red spring wheat grown during one or more of the seven years from 1915 to 1921, inclusive.*

Variety.	Test weight per bushel (milled-cleaned).	Crude protein of wheat.	Milling yields.			Water absorption of flour.	Volume of loaf.	Weight of loaf.	Texture of loaf.	Color of loaf.	Ash in flour.
			Straight flour.	Shorts.	Bran.						
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Marquis	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Chul	99.8	96.6	99.6	101.3	100.8	102.3	85.3	101.4	98.6	99.9	98.0
Ghirka	98.6	92.8	95.5	103.4	119.4	99.7	90.3	99.8	94.3	94.6	92.0
Glyndon	97.6	101.3	99.1	94.0	112.2	99.0	90.9	99.4	96.4	95.7	94.0
Haynes Bluestem	95.6	100.6	99.7	94.3	107.9	100.8	94.6	100.0	98.8	97.2	104.2
Kitchener	97.7	92.2	100.0	102.9	97.3	100.0	95.0	100.8	100.6	98.4	98.0
Kota	104.5	104.0	102.6	104.9	85.0	107.0	95.1	101.8	101.6	97.6	113.2
Norka	103.0	109.3	103.0	107.3	79.1	99.5	78.3	100.4	99.4	94.6	114.9
Pioneer	101.2	104.5	101.9	99.4	91.3	100.0	98.8	99.4	99.3	100.6	100.0
Power	100.2	101.9	101.3	94.3	100.0	100.8	90.3	100.4	96.9	96.6	97.9
Prelude	102.4	108.5	104.0	92.1	89.3	99.2	97.5	99.8	96.5	96.2	106.1
Preston	101.5	99.4	100.0	95.7	104.9	99.3	94.2	99.6	98.0	97.5	98.0
Red Bobs	97.4	96.0	102.4	91.2	97.4	100.2	97.6	99.8	100.6	98.8	96.1
Red Fife	98.2	99.4	101.0	100.7	94.8	100.3	90.4	100.8	100.6	98.9	90.9
Ruby	101.4	103.4	100.1	106.1	93.5	103.3	95.4	101.2	100.3	101.3	106.1

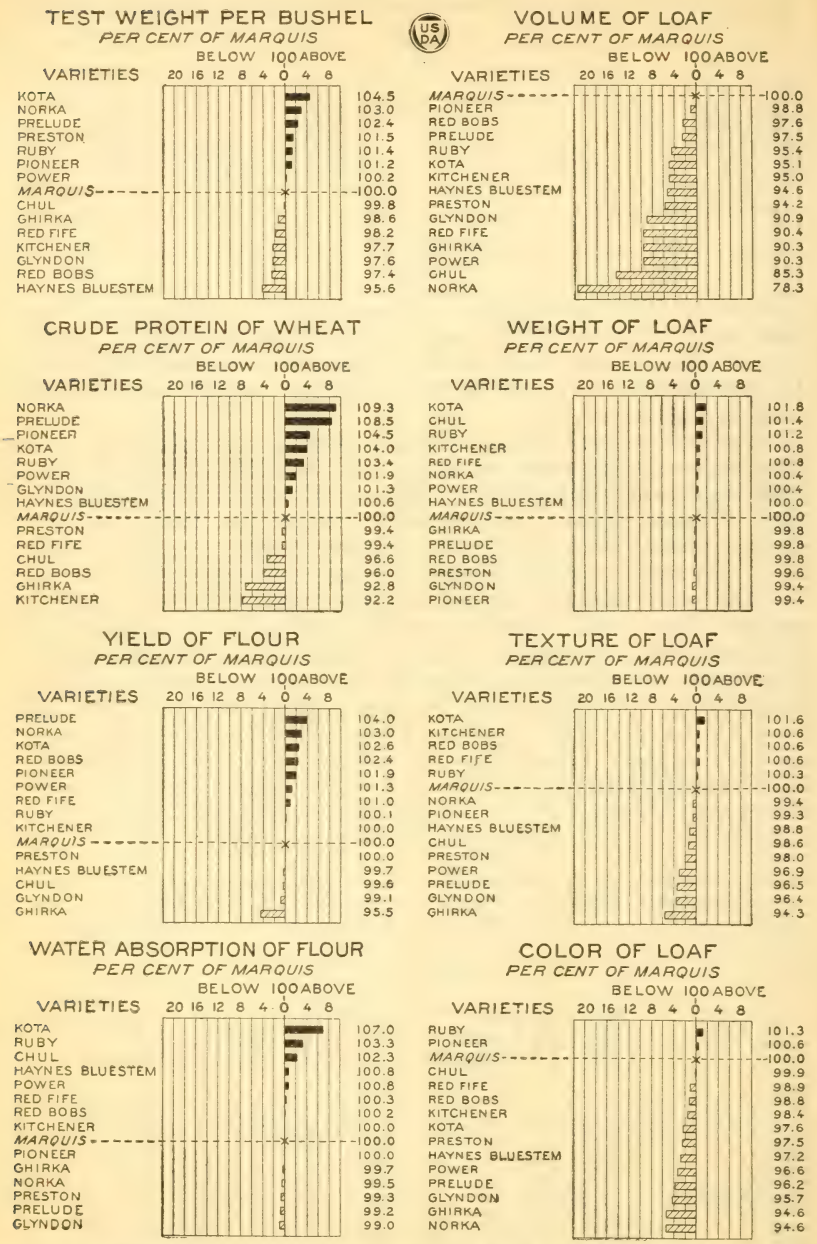


FIG. 3.—A comparison of the milling and baking data, in percentage of Marquis, from samples of each of 14 other varieties of Hard Red Spring wheat grown under comparable conditions with Marquis. (Data from Table 24.)

THE DURUM WHEATS.[7]

The commercial class of wheat known as durum and defined in the official grain standards of the United States as including all varieties of durum wheats is grown in almost the same region as hard red spring wheat. The States leading in its production are North Dakota, South Dakota, and Montana. The area of heaviest production of durum wheat is just west of the Red River Valley in North Dakota. About 4,000,000 acres of durum wheat have been grown annually in the United States for several years. In 1919, as shown in Table 26, the acreage exceeded 4,000,000 acres. This comprises about one-sixteenth of the total wheat acreage of the United States. The distribution of durum wheat in 1919 is shown in Figure 4. Durum wheat usually yields more per acre than hard red spring wheat in this northern spring-wheat region because of its greater resistance to drought and to black stem rust. Much of the durum wheat is ground into a granular semolina, from which macaroni, spaghetti, and other alimentary pastes are made. Some durum wheat, however, is blended with other classes of wheat in the manufacture of bread-making flours. Very little, if any, bread is made from durum wheat flour alone in this country. The results of milling and baking experiments with durum wheat varieties recorded in this bulletin will be of value principally for use in blending, as these data have little or no relation to the value of durum wheat for the manufacture of macaroni and other edible pastes.

TABLE 26.—*Estimated acreage of durum wheat, 1919.*

State.	Acres.	State.	Acres.
North Dakota	2,707,400	Kansas	43,200
South Dakota	688,700	Texas	40,800
Montana	281,600	Iowa	15,400
Nebraska	206,100	Other	57,200
Colorado	148,200		
Minnesota	137,300	United States	4,370,800
Wyoming	44,900		

Twelve varieties of durum wheat are grown commercially in the United States. The leading varieties are Arnautka and Kubanka. In recent years the Kubanka has become widely grown, and as it is the variety best adapted to all of the varying conditions in the durum-wheat producing sections, it is used as the basis for comparison of other durum varieties discussed in this bulletin.

Milling and baking experiments have been conducted with most of the commercially grown varieties of durum wheat. Five or more tests have been made of 10 of the varieties. Two additional varieties which have been grown experimentally, but not commercially, have been tested. A summary of the results of experiments on the milling and baking samples of durum wheat varieties is shown in Table 27. The States from which the samples were obtained are shown in Table 28.

As in the case of the hard red spring wheat varieties, a number of the samples of many of the varieties of the durum class have been

[7] For more complete information concerning the varieties and adaptation of Durum wheat, see Clark, J. Allen, Martin, John H., and Smith, Ralph W.: Varietal Experiments with Spring Wheat on the Northern Great Plains. U. S. Dept. Agr. Bul. 878, 1920, and Clark, J. Allen, and Martin, John H.: The Durum Wheats, U. S. Dept. Agr., Farmers' Bul. 1304.

grown under the same conditions as one of the other varieties, namely, Kubanka. Where the results from comparable samples are available, separate tables showing the data are presented. Photo-

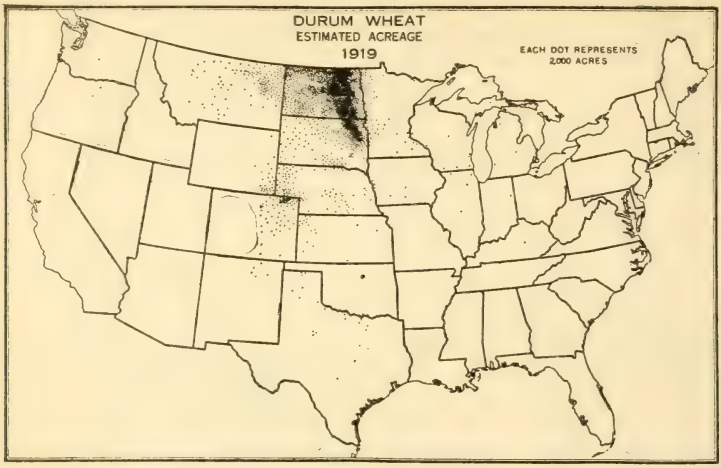


FIG. 4.—Distribution of wheat of the durum class.

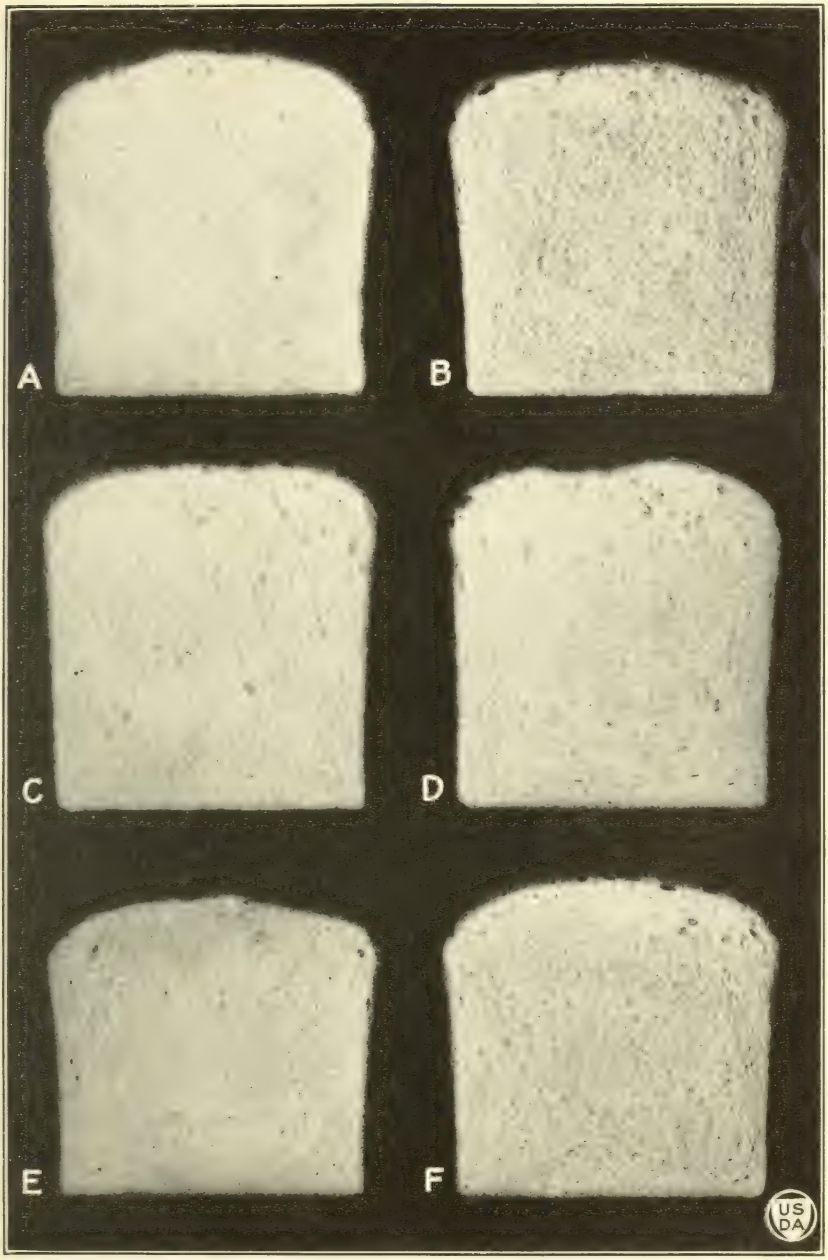
graphs showing the relative differences in the quality of bread made from some of the principal varieties of this class of wheat are found in Plate II.

TABLE 27.—*Summary of milling and baking data on durum wheat varieties grown during the seven years from 1915 to 1921, inclusive.*

Variety.	Number of samples.[1]	Test weight per bushel.		Crude protein of wheat.	Milling yields.			Baking results.					Ash in flour.
		Dockage-free.	Mill-cleaned.		Straight flour.	Shorts.	Bran.	Water absorption of flour.	Loaf.				
									Volume.	Weight.	Texture.	Color.	
		Lbs.	*Lbs.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*C. c.*	*Gms.*	*Score.*	*Score.*	*P. ct.*
Acme	39	60.3	60.7	15.1	71.1	18.2	10.7	63.7	1,944	508	89.0	86.8	0.78
Arnautka	76	59.5	60.0	15.7	71.4	17.9	10.7	61.1	2,008	497	91.0	91.0	.75
Buford	6	60.7	60.7	14.5	74.4	14.3	11.3	60.4	1,722	492	88.0	87.5	.69
Golden Ball	11	58.3	58.5	15.7	71.6	18.1	10.3	61.4	1,644	498	83.5	86.7	.79
Kahla	7	60.0	60.4	15.1	69.8	18.3	11.8	62.2	2,106	501	90.8	86.6	.81
Kubanka	99	59.6	60.2	16.0	70.9	18.1	11.0	62.5	2,014	500	90.6	89.7	.80
Kubanka No. 8	34	60.1	60.6	15.5	70.5	19.5	10.0	60.8	2,012	496	90.4	90.4	.72
Kubanka No. 98	8	59.2	59.6	15.5	71.6	18.1	10.3	64.0	1,944	508	88.5	86.9	.78
Mindum	13	61.3	60.6	15.0	75.3	14.1	10.6	60.6	1,744	499	88.2	84.2	.79
Monad	26	59.9	60.2	15.3	71.4	17.3	11.3	63.4	1,980	506	90.3	88.0	.78
Peliss	27	59.6	59.8	16.5	72.2	18.0	9.8	66.7	1,894	518	88.0	87.4	.83
Pentad (D-5)	41	60.6	61.1	14.2	68.7	18.7	12.6	61.6	1,751	502	86.6	85.2	.70
Average of varietal samples (Max. No. 387)		59.9	60.3	15.5	71.1	18.0	10.9	62.4	1,943	502	89.5	88.6	.77
Average of class[2] (Max. No. 432)		59.3	.....	14.9	70.6	17.8	11.6	62.0	1,945	507	89.7	88.1	.77

[1] This column contains the maximum number of samples used for each variety. In some instances, particularly for the factors of loaf color and ash the results given represent the average of a fewer number of samples for the reason that complete data on all the samples were not available. The number of samples used for the various factors is given in Figures No. 12 to 23, inclusive.

[2] Average of all durum wheat samples on which tests were made including the varietal samples shown above.



LOAVES OF BREAD FROM SIX VARIETIES OF DURUM WHEAT GROWN AT DICKINSON, N. DAK., IN 1920.

The varieties, with the average loaf volumes, are as follows: *A*, Arnautka, 2,020 c. c.; *B*, Kubanka, 1,920 c. c.; *C*, Peliss, 1,990 c. c.; *D*, Acme, 1,900 c. c.; *E*, Mindum, 1,720 c. c.; *F*, Pentad, 1,790 c. c.

TABLE 28.—*Number of samples of each variety of durum wheat grown in each State, the data on which are shown in Table 27.*

Variety.	North Dakota.	South Dakota.	Montana.	Wyoming.	Colorado.	Minnesota.	Nebraska.	Texas.	Oregon.	Utah.	Washington.	Kansas.	Idaho.	Origin unknown.	Total.
Acme	9	12	2	4	2	6	2	....	2	....	....	....	....	....	39
Arnautka	20	13	11	11	9	4	5	3	....	....	....	....	....	....	76
Buford	3	1	....	2	....	....	....	....	....	....	....	....	....	....	6
Golden Ball	3	1	1	2	2	....	....	1	1	....	....	....	....	....	11
Kahla	....	4	1	....	2	....	....	....	....	....	....	....	....	....	7
Kubanka	33	18	12	9	6	4	4	2	1	4	4	1	1	....	99
Kubanka No. 8	15	4	3	3	2	3	2	2	....	....	....	....	....	....	34
Kubanka No. 98	6	....	1	....	....	1	....	....	....	....	....	....	....	....	8
Mindum	5	1	....	2	....	5	....	....	....	....	....	....	....	....	13
Monad	10	2	5	3	3	2	1	....	....	....	....	....	....	....	26
Peliss	4	....	12	8	3	....	....	....	....	....	....	....	....	....	27
Pentad (D–5)	18	5	4	3	3	6	....	....	....	....	....	....	....	2	41
Total	126	61	52	47	32	31	14	8	4	4	4	1	1	2	387

Acme.—Acme durum wheat originated as a pure-line selection from Kubanka, made at the Highmore, S. Dak., substation in 1909 by M. J. Champlin, then of the United States Department of Agriculture. Because of its high yield it was distributed for commercial growing in 1916, when it was also discovered to be resistant to stem rust. About 5,000 acres of Acme were grown in 1919 and somewhat more than 50,000 acres in 1921.

Acme is a bearded amber durum variety and differs from Kubanka in being shorter and in having weaker straw and shorter kernels. It is the highest yielding variety of durum wheat in most of South Dakota and is exceeded only by Monad in North Dakota. It is almost immune from rust injury under field conditions.

Thirty-nine samples of Acme wheat have been tested for their milling and baking values from samples obtained mostly from experiment stations in South Dakota, North Dakota, Minnesota, Montana, Wyoming, Colorado, and Nebraska during the six years from 1916 to 1921, inclusive. Of the 39 samples, 24 can be directly compared with comparable samples of Kubanka, grown under the same conditions. A summary of these comparable tests is shown in Table 29. The results show that Acme is slightly inferior to Kubanka in crude protein content and in loaf volume. In other respects, however, the Acme is about equal or slightly superior to Kubanka, and in general is but slightly inferior to that variety for milling and bread-making purposes. It produces macaroni of a grayish color, which is considered by macaroni manufacturers to be less salable than that made from Kubanka.

TABLE 29.—*Summary of milling and baking data on 24 samples of Acme and 24 comparable samples of Kubanka grown during the six years from 1916 to 1921, inclusive.*

Descriptive data.	Acme.	Kubanka.	Percentage of Kubanka.
Number of samples	24	24	....
Test weight per bushel (mill-cleaned wheat)....pounds..	60.8	60.3	100.8
Crude protein content of wheat....per cent..	14.9	15.6	95.5
Yield of straight flour....do....	71.8	72.1	99.6
Yield of shorts....do....	17.5	17.2	101.7
Yield of bran....do....	10.7	10.7	100.0

TABLE 29.—*Summary of milling and baking data on 24 samples of Acme and 24 comparable samples of Kubanka grown during the six years from 1916 to 1921, inclusive*—Continued.

Descriptive data.	Acme.	Kubanka.	Percentage of Kubanka.
Water absorption of flour.....per cent..	64.0	63.3	101.1
Volume of loaf.....cubic centimeters..	1,943	2,058	94.4
Weight of loaf.....grams..	507	506	100.2
Texture of loaf.....score..	90.0	90.6	99.3
Color of loaf.....do....	88.3	88.2	100.1
Ash in flour.....per cent..	0.79	0.79	100.0

Arnautka.—Arnautka, known also as Goose or Wild Goose, Nicaragua, and Pierson, is the oldest variety of durum wheat grown in the United States. Although it was introduced into this country by the United States Department of Agriculture in 1864, most of the variety now grown probably was brought to this country originally by immigrants from Russia. It was grown by them in North Dakota previous to 1900, and was the source of much of the durum wheat grown in the United States at that time. Arnautka differs from Kubanka in having longer, narrower, and more lax and nodding spikes. In yield per acre Arnautka is inferior to Kubanka, Peliss, and Mindum in the sections where these varieties are well adapted, and it should be replaced by them.

Seventy-six samples of the Arnautka variety have been tested for their milling and bread-making value during the seven years from 1915 to 1921, inclusive. These samples represent both the original commercial variety and some selections from it. Principal among the selections is the strain known as C. I. No. 4064, which has been grown most extensively and which is typical of the true Arnautka variety. The commercial samples as a rule are considerably mixed. The samples here reported for the most part were obtained from the experiment stations in the Great Plains area, principally in North Dakota, South Dakota, and Montana. Sixty-two of the 76 samples are directly comparable with samples of Kubanka grown under similar conditions. These comparable results are shown in Table 30. The results show that there is little, if any, difference in the milling and bread-making values of the Arnautka and Kubanka varieties. Arnautka has averaged slightly higher in crude protein, but slightly lower in yield of flour, water absorption, and volume of loaf.

TABLE 30.—*Summary of milling and baking data on 62 samples of Arnautka and 62 comparable samples of Kubanka grown during the seven years from 1915 to 1921, inclusive.*

Descriptive data.	Arnautka.	Kubanka.	Percentage of Kubanka.
Number of samples	62	62	.....
Test weight per bushel (mill-cleaned wheat).....pounds..	60.0	60.8	98.7
Crude protein content of wheat.....per cent..	16.1	15.6	103.2
Yield of straight flour.....do....	71.2	71.4	99.7
Yield of shorts.....do....	18.4	18.3	100.5
Yield of bran.....do....	10.4	10.3	101.0
Water absorption of flour.....do....	61.1	62.3	98.1
Volume of loaf.....cubic centimeters..	2,013	2,041	98.6
Weight of loaf.....grams..	497	499	99.6
Texture of loaf.....score..	91.0	90.0	101.1
Color of loaf[1].....do....	91.4	89.8	101.8
Ash in flour[2].....per cent..	0.76	0.73	104.1

[1] Average of 61 samples.

[2] Average of 31 samples.

Buford.—Buford is a selection from Taganrog durum wheat made by F. R. Babcock, of the United States Department of Agriculture, at Williston, N. Dak., in 1909. Because of its high yield of grain, it was distributed in 1917 from the Williston substation of the North Dakota Agricultural Experiment Station. Buford is similar to Kubanka, except that it has larger spikes and kernels. This variety is not very resistant to rust and is well adapted only to northwestern North Dakota and northeastern Montana.

As shown in Table 27, six samples of Buford wheat have been milled and baked. Five of these samples are directly comparable with samples of Kubanka. These data are shown in Table 31. The samples were obtained from the Williston and Dickinson substations in North Dakota and from stations in South Dakota and Wyoming, representing four crop years, 1918 to 1921, inclusive.

The data show the Buford variety to be similar to Kubanka in the milling factors but considerably inferior in bread-making value, as it is significantly lower in volume, texture, and color of loaf. It is also considerably higher in ash in flour. Because of the poorer bread-making qualities of the Buford variety and because of its susceptibility to stem rust, an increase in its acreage has not been encouraged in recent years, although its value for the manufacture of macaroni appears to be very satisfactory.

TABLE 31.—*Summary of milling and baking data on five samples of Buford and five comparable samples of Kubanka grown during the four years from 1918 to 1921, inclusive.*

Descriptive data.	Buford.	Kubanka.	Percentage of Kubanka.
Number of samples	5	5	
Test weight per bushel (mill-cleaned wheat)..pounds..	60.0	61.3	97.9
Crude protein content of wheat..per cent..	15.2	15.5	98.1
Yield of straight flour..do....	74.3	74.0	100.4
Yield of shorts..do....	14.1	14.7	95.9
Yield of bran..do....	11.6	11.3	102.7
Water absorption of flour..do....	60.2	63.9	94.2
Volume of loaf..cubic centimeters..	1,766	2,072	85.2
Weight of loaf..grams..	498	509	97.8
Texture of loaf..score..	86.8	92.5	93.8
Color of loaf..do....	86.0	89.6	96.0
Ash in flour..per cent..	0.70	0.64	109.4

Golden Ball.—Golden Ball wheat was introduced into the United States by the United States Department of Agriculture in 1918 from Johannesburg, South Africa, where it is recognized as a valuable drought-resistant and rust-resistant variety. It has black awns, pubescent white glumes, and very large amber kernels. Since its introduction it has been carefully tested at several experiment stations in the durum wheat section of the United States, but it has not proved to be a high-yielding variety nor especially resistant to either rust or drought.

Eleven samples of the Golden Ball variety have been milled and baked; the data are shown in Table 27. Nine of these samples are directly comparable with samples of Kubanka, the data on which are shown in Table 32. The data show that Golden Ball has a high crude protein content, but is inferior to Kubanka in yield of flour, water absorption, and volume, weight, texture, and

color of loaf. It exceeds the Kubanka in ash content of flour. As the variety has not proved to be a good yielding variety and as these milling experiments have shown it to be very poor for milling and bread making, the variety has been discontinued from experiments and has not become commercially grown in the United States.

TABLE 32.—*Summary of milling and baking data on nine samples of Golden Ball and nine comparable samples of Kubanka grown in the two years 1919 and 1920.*

Descriptive data.	Golden Ball.	Kubanka.	Percentage of Kubanka.
Number of samples	9	9	
Test weight per bushel (mill-cleaned wheat)....pounds..	58.3	59.4	98.1
Crude protein content of wheat....per cent..	16.0	15.6	102.6
Yield of straight flour....do....	70.9	72.7	97.5
Yield of shorts....do....	18.7	15.7	119.1
Yield of bran....do....	10.4	11.6	89.7
Water absorption of flour....do....	61.1	64.8	94.3
Volume of loaf....cubic centimeters..	1,659	2,120	78.3
Weight of loaf....grams..	497	511	97.3
Texture of loaf....score..	82.7	91.7	90.2
Color of loaf....do....	86.3	88.8	97.2
Ash in flour....per cent..	0.82	0.73	112.3

Kahla.—Kahla, known also as Black Don, Black Durum, Black-Chaff Durum, Black Emmett, Purple Durum, and Sloat, is of Algerian origin, introduced by the United States Department of Agriculture as early as 1901. Similar samples have been obtained from Russia in recent years. The variety has been grown considerably in Montana and to a less extent in the western part of North Dakota and South Dakota. It has black awns and glumes and large white (amber) kernels. As commercially grown the variety is usually mixed with Marquis spring wheat. Several mixed samples have been milled, but only seven samples have been tested which did not grade as mixed wheat. The results on these are shown in Table 27. The data show the Kahla variety to compare very favorably in milling and baking qualities with other varieties of durum wheat. It produces a somewhat low yield of flour, but ranks high in water absorption and loaf volume. In general, as compared with other durum wheats, Kahla has good milling and bread-making qualities. Kahla has yielded less than other durum varieties in comparative experiments and its cultivation should be discontinued.

Kubanka.—Kubanka wheat was introduced into this country from Russia by the United States Department of Agriculture. Seed was increased and distributed by that department and the North Dakota and South Dakota Agricultural Experiment Stations from 1901 to 1909. Kubanka is probably the best-known durum wheat and is considered the variety best adapted for all of the varying conditions in the durum-wheat producing sections, although it usually is outyielded by Acme and Monad in the Dakotas, by Mindum in Minnesota, and by Peliss in Montana, Wyoming, and Colorado. Kubanka has yellow awns and glumes, rather short compact spikes, and large white (amber) kernels. It is fairly resistant to rust under field conditions. Kubanka is extensively grown in North Dakota, South Dakota, Montana, and other northern Great Plains States. Because of its importance and its wide adaptation Kubanka is used as a standard of comparison for other durum wheats in this bulletin.

In all, 99 milling and baking experiments have been conducted with the variety. Most of the samples were obtained from the northern Great Plains region during the seven years from 1915 to 1921, inclusive. Several commercial samples are included, however, as well as a number of pure-line selections. The data presented in Table 27 show Kubanka to be superior to most of the durum varieties in both milling and bread-making factors.

Kubanka No. 8.—Kubanka No. 8 (C. I. No. 4063), was originated by selection from Kubanka, C. I. No. 1440, made by Prof. L. R. Waldron at the Dickinson substation in North Dakota in 1906. It was distributed to growers in western North Dakota as early as 1911. Further distributions have been made during most years since that date. It is similar in appearance to the original Kubanka, but is more susceptible to rust and has not yielded as well, except in southwestern North Dakota.

In all, 34 samples of the Kubanka No. 8 have been milled and baked and the average results from these are shown in Table 27. Twenty-eight of these samples are directly comparable with the original Kubanka variety, and these comparable data are summarized in Table 33. The data show this selection to be about equal to Kubanka in both milling and bread-making factors, the principal difference being in a higher percentage of ash in the flour.

TABLE 33.—*Summary of milling and baking data on 28 samples of Kubanka No. 8 and 28 comparable samples of Kubanka grown during the seven years from 1915 to 1921, inclusive.*

Descriptive data.	Kubanka No. 8.	Kubanka.	Percentage of Kubanka.
Number of samples	28	28	
Test weight per bushel (mill-cleaned wheat).....pounds..	60.6	61.1	99.2
Crude protein of wheat.....per cent..	15.5	15.5	100.0
Yield of straight flour.....do....	70.2	70.3	99.9
Yield of shorts.....do....	20.0	19.8	101.0
Yield of bran.....do....	9.8	9.9	99.0
Water absorption of flour.....do....	60.6	61.5	98.5
Volume of loaf.....cubic centimeters..	1,968	1,997	98.5
Weight of loaf.....grams..	495	492	100.6
Texture of loaf.....score..	89.9	89.0	101.0
Color of loaf.....do....	90.9	89.9	101.1
Ash in flour [1].....per cent..	0.76	0.72	105.6

[1] Average of 8 samples.

Kubanka No. 98.[8]—Kubanka No. 98 is a more recent selection of Kubanka wheat developed by R. W. Smith at the Dickinson substation, Dickinson, N. Dak. This selection is resistant to stem rust and has proved to be a high yielding variety. As it is also well adapted for the manufacture of macaroni and is a good milling and bread-making wheat, it is now being increased for commercial distribution. In appearance it is very similar to the original Kubanka. Eight samples of Kubanka No. 98 have been milled and baked, and the data are summarized in Table 27. Seven of these samples are comparable with Kubanka, and these data are shown in Table 34. It will be noted that Kubanka No. 98 has averaged slightly lower in test weight per bushel and crude protein content, but is slightly superior to Kubanka in yield of flour and water absorption. In bread-

[8] Since the preparation of this bulletin Kubanka No. 98 has been named Nodak.

making factors it has averaged somewhat lower in loaf volume and in texture and color of loaf. It also has a somewhat higher ash in the flour.

TABLE 34.—*Summary of milling and baking data on seven samples of Kubanka No. 98 and seven comparable samples of Kubanka grown during the four years from 1918 to 1921, inclusive.*

Descriptive data.	Kubanka No. 98.	Kubanka.	Percentage of Kubanka.
Number of samples	7	7	
Test weight per bushel (mill-cleaned wheat)....pounds..	59.8	60.4	99.0
Crude protein content of wheat....per cent..	15.7	16.1	97.5
Yield of straight flour....do....	72.2	71.7	100.7
Yield of shorts....do....	17.4	17.3	100.6
Yield of bran....do....	10.4	11.0	94.5
Water absorption of flour....do....	64.0	63.8	100.3
Volume of loaf....cubic centimeters..	1,914	2,016	94.9
Weight of loaf....grams..	507	509	99.6
Texture of loaf....score..	87.5	90.3	96.9
Color of loaf....do....	87.0	87.4	99.5
Ash in flour....per cent..	0.79	0.75	105.3

Mindum.—Mindum wheat was developed by selection at the Minnesota Agricultural Experiment Station, and was distributed to Minnesota farmers in 1917. It is now grown in Minnesota and North Dakota, principally in the Red River Valley section. It is similar to Arnautka, except that it is taller, has stronger straw, and is less susceptible to stem rust. The kernels of Mindum have an extremely short brush. Mindum outyields all other durum varieties in Minnesota, but is not well adapted to other States.

Thirteen samples of Mindum wheat have been milled and baked and the results are summarized in Table 27. Eight of these samples can be directly compared with samples of Kubanka grown under the same conditions. These comparable data are shown in Table 35. The data show Mindum to be about equal or slightly inferior to Kubanka in test weight per bushel, crude protein content, and yield of flour. In water absorption and in volume, texture, and color of loaf, however, it is distinctly inferior to Kubanka. It also has a considerably higher ash in the flour. While the Mindum variety has been shown to be well adapted for the manufacture of macaroni, in these milling and baking experiments it has proved to be a poor variety for bread making.

TABLE 35.—*Summary of milling and baking data on eight samples of Mindum and eight comparable samples of Kubanka grown during the three years from 1919 to 1921, inclusive.*

Descriptive data.	Mindum.	Kubanka.	Percentage of Kubanka.
Number of samples	8	8	
Test weight per bushel (mill-cleaned wheat)....pounds..	60.4	60.5	99.8
Crude protein content of wheat....per cent..	15.6	15.2	102.6
Yield of straight flour....do....	75.7	72.7	104.1
Yield of shorts....do....	13.9	16.7	83.2
Yield of bran....do....	10.4	10.6	98.1
Water absorption of flour....do....	61.0	64.2	95.0
Volume of loaf....cubic centimeters..	1,744	2,030	85.9
Weight of loaf....grams..	502	512	98.0
Texture of loaf....score..	88.7	92.0	96.4
Color of loaf....do....	85.1	89.1	95.5
Ash in flour....per cent..	0.81	0.73	111.0

Monad.—Monad durum wheat was obtained from Russia by Prof. H. L. Bolley, of the North Dakota Agricultural Experiment Station, in 1903. The variety was distributed by Professor Bolley as D–1 in 1911, but was later named Monad. It is similar to Acme in appearance and rust resistance. This variety is grown principally in North Dakota, where it is the highest yielding variety of durum wheat. Largely because of its resistance to stem rust and its high acre yield, the acreage of Monad has increased rapidly since 1919.

Twenty-six samples of the Monad variety have been milled and baked, and the data are summarized in Table 27. Twenty-five of these samples are directly comparable with samples of Kubanka grown under identical conditions. All of these samples were obtained from experiment stations in the northern spring wheat area during the seven years from 1915 to 1921, inclusive. The comparable data are summarized in Table 36.

The data show the Monad variety to be practically equal to the Kubanka variety in the milling factors, but to be slightly lower in volume and weight of loaf. In general, Monad compares favorably with other durum varieties for milling and breadmaking. It produces macaroni, however, of a somewhat grayish color, which is considered by macaroni manufacturers to be less salable than that made from Kubanka.

TABLE 36.—*Summary of milling and baking data on 25 samples of Monad and 25 comparable samples of Kubanka grown during the seven years from 1915 to 1921, inclusive.*

Descriptive data.	Monad.	Kubanka.	Percentage of Kubanka.
Number of samples	25	25	
Test weight per bushel (mill-cleaned wheat).....pounds..	60.3	60.1	100.3
Crude protein content of wheat.....per cent..	15.4	15.5	99.4
Yield of straight flour.....do....	71.6	71.9	99.6
Yield of shorts.....do....	17.3	16.6	104.2
Yield of bran.....do....	11.1	11.5	96.5
Water absorption of flour.....do....	63.5	64.1	99.1
Volume of loaf.....cubic centimeters..	1,984	2,040	97.3
Weight of loaf.....grams..	507	510	99.4
Texture of loaf.....score..	90.5	89.9	100.7
Color of loaf.....do....	88.5	88.0	100.6
Ash in flour[1].....per cent..	0.76	0.76	100.0

[1] Average of 22 samples.

Peliss.—The Peliss (Pelissier) variety probably is more commonly known on the farms as Black Bearded durum. It was introduced in 1900 from Algeria by the United States Department of Agriculture. It has long black awns, white glabrous glumes, and very long white (amber) kernels. Careful experiments have proved the variety to be well adapted to the higher and drier sections of the durum wheat area in Montana, Wyoming, and Colorado. After thorough testing it was increased and distributed, principally in Montana, where it has been grown commercially since 1918. Partly because of its susceptibility to rust, it is less productive than other durum varieties in the Dakotas and Minnesota. The large size of the Peliss kernel causes some trouble in cleaning with the present commercial machinery, but otherwise the variety is satisfactory and has proved exceptionally well adapted for the manufacture of macaroni.

Twenty-seven samples of Peliss have been milled and baked, as shown in Table 27. All of these samples were obtained from experi-

ment stations in the northern Great Plains area of the United States during the seven years from 1915 to 1921, inclusive. All are directly comparable with samples of Kubanka, and the comparison is shown in Table 37.

The experiments show Peliss to be practically equal to Kubanka in test weight per bushel, crude protein content, and yield of flour. It is somewhat higher in water absorption but slightly lower in volume, texture, and color of loaf. It has averaged considerably higher than Kubanka in ash in the flour.

TABLE 37.—*Summary of milling and baking data on 27 samples of Peliss and 27 comparable samples of Kubanka grown during the seven years from 1915 to 1921, inclusive.*

Descriptive data.	Peliss.	Kubanka.	Percentage of Kubanka.
Number of samples	27	27	
Test weight per bushel (mill-cleaned wheat).....pounds..	59.6	60.3	98.8
Crude protein content of wheat.....per cent..	16.6	16.5	100.6
Yield of straight flour.....do....	72.0	71.4	100.8
Yield of shorts.....do....	17.7	17.7	100.0
Yield of bran.....do....	10.3	10.9	94.5
Water absorption of flour.....do....	66.7	64.2	103.9
Volume of loaf.....cubic centimeters..	1,912	1,967	97.2
Weight of loaf.....grams..	520	507	102.6
Texture of loaf.....score..	88.5	89.0	99.4
Color of loaf.....do....	87.9	88.5	99.3
Ash in flour.....per cent..	0.84	0.75	112.0

Pentad (D–5).—The Pentad or D–5 variety, known also as "D–Fife," Ladd Durum, Red Durum, Resistant Fife, and Rustproof, was introduced from Russia in 1903 by Prof. H. L. Bolley, of the North Dakota Agricultural Experiment Station. It was distributed by Professor Bolley in 1911, and because of its resistance to stem rust has become rather widely grown in the durum wheat area. It has white, glabrous glumes, white awns, and midsized red kernels. It is practically immune from rust injury and yields well under rust conditions, but usually is not as productive as Acme and Monad even in severe rust epidemics. More than 50,000 acres of the variety were reported grown in 1919. Since that year its acreage has materially increased.

Forty-one samples of the Pentad variety have been milled and baked and the data are summarized in Table 27. Many of these samples are from commercial sources, coming from the farms in North Dakota or from local or terminal elevators. Sixteen of these samples were obtained from experiment stations in the northern Great Plains area and can be directly compared with Kubanka. These comparisons are shown in Table 38.

The data show the Pentad variety to average slightly higher than Kubanka in test weight per bushel and nearly the same in crude protein content. It has, however, produced a considerable lower yield of flour. In water absorption and in volume, weight, texture, and color of loaf it has averaged lower than Kubanka and is especially deficient in loaf volume. In general, it is the poorest of the commercially grown durum varieties for milling and bread making and is not well adapted for the manufacture of macaroni. It should no longer be grown in this country. Because it is poorer in milling, baking, and macaroni value than the other durum varieties, a special subclass under the Durum class, called Red Durum, has been provided for it in the Federal standards for wheat.

TABLE 38.—*Summary of milling and baking data on 16 samples of Pentad (D–5) and 16 comparable samples of Kubanka grown during the five years from 1917 to 1921, inclusive.*

Descriptive data.	Pentad (D–5).	Kubanka.	Percentage of Kubanka.
Number of samples	16	16	
Test weight per bushel (mill-cleaned wheat)....pounds..	61.4	60.2	102.0
Crude protein content of wheat....per cent..	15.9	16.0	99.4
Yield of straight flour....do....	69.1	72.8	94.9
Yield of shorts....do....	18.3	16.1	113.7
Yield of bran....do....	12.6	11.1	113.5
Water absorption of flour....do....	63.8	64.3	99.2
Volume of loaf....cubic centimeters..	1,736	1,994	87.1
Weight of loaf....grams..	508	511	99.4
Texture of loaf....score..	87.0	90.4	96.2
Color of loaf....do....	85.4	89.2	95.7
Ash in flour [1]....per cent..	0.73	0.72	101.4

[1] Average of 15 samples.

SUMMARY OF MILLING AND BAKING DATA ON THE VARIETIES OF DURUM WHEAT.

A summary of the data on the important milling and baking factors shown in Tables 29 to 38, inclusive, is given in Table 39 and graphically in Figure 5, in percentage of Kubanka for each variety. In the factors concerned with baking quality Kubanka leads all varieties, it is distinctly superior in loaf volume and superior to most of the varieties in the other quality factors. All varieties have a higher ash content of flour than Kubanka, except Acme and Monad, which are equal to Kubanka. Arnautka, Golden Ball, and Mindum have the highest protein content and Mindum the highest flour yield. The varieties are similar in test weight per bushel, but Pentad is highest and Buford lowest in this respect. Kubanka, Kubanka No. 8, Kubanka 98, Arnautka, and Peliss are the best varieties of durum wheat for bread making, and Pentad, Buford, and Mindum are among the poorest. As previously stated, these comparisons do not necessarily apply to the macaroni value of the varieties for Mindum and Buford, as well as Kubanka and Arnautka, produce excellent macaroni. Pentad, Acme, and Monad are known to produce macaroni of a grayish color, but the other durum varieties are satisfactory for macaroni manufacture.

TABLE 39.—*Summary of milling and baking data, in percentage of Kubanka, on comparable samples of 10 other varieties of durum wheat grown during one or more of the seven years from 1915 to 1921, inclusive.*

Variety.	Test weight per bushel (mill-cleaned).	Crude protein of wheat.	Milling yields.			Water absorption of flour.	Volume of loaf.	Weight of loaf.	Texture of loaf.	Color of loaf.	Ash in flour.
			Straight flour.	Shorts.	Bran.						
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Kubanka	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Acme	100.8	95.5	99.6	101.7	100.0	101.1	94.4	100.2	99.3	100.1	100.0
Arnautka	98.7	103.2	99.7	100.5	101.0	98.1	98.6	99.6	101.1	101.8	104.1
Buford	97.9	98.1	100.4	95.9	102.7	94.2	85.2	97.8	93.8	96.0	109.4
Golden Ball	98.1	102.6	97.5	119.1	89.7	94.3	78.3	97.3	90.2	97.2	112.3
Kubanka No. 8	99.2	100.0	99.9	101.0	99.0	98.5	98.5	100.6	101.0	101.1	105.6
Kubanka No. 98	99.0	97.5	100.7	100.6	94.5	100.3	94.9	99.6	96.9	99.5	105.3
Mindum	99.8	102.6	104.1	83.2	98.1	95.0	85.9	98.0	96.4	95.5	111.0
Monad	100.3	99.4	99.6	104.2	96.5	99.1	97.3	99.4	100.7	100.6	100.0
Peliss	98.8	100.6	100.8	100.0	94.5	103.9	97.2	102.6	99.4	99.3	112.0
Pentad	102.0	99.4	94.9	113.7	113.5	99.2	87.1	99.4	96.2	95.7	101.4

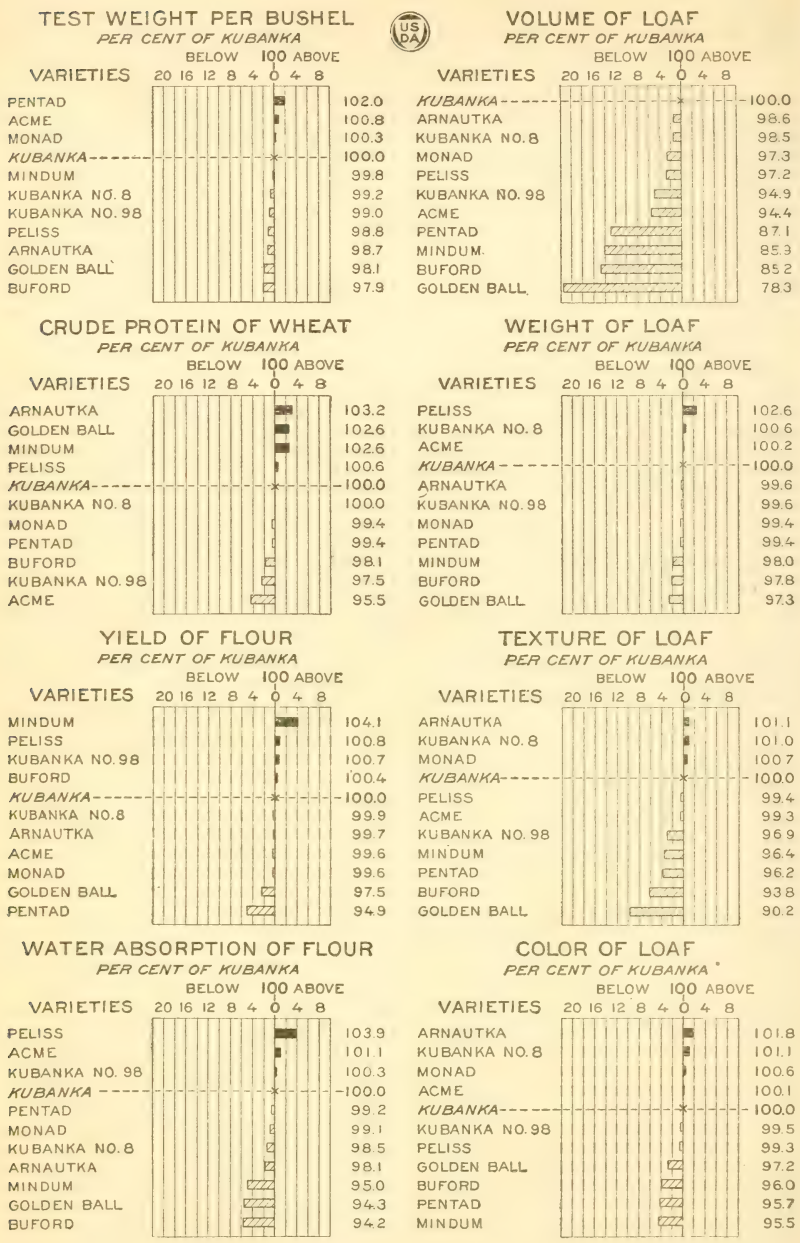


FIG. 5.—A comparison of the milling and baking data, in percentage of Kubanka, from samples of each of 10 other varieties of Durum wheat grown under comparable conditions with Kubanka. (Data from Table 37.)

THE HARD RED WINTER WHEATS.[9]

The commercial class of wheat known as Hard Red Winter, which includes all the varieties of hard red winter common wheats, is grown principally in the central Great Plains area, where hot summers and rather severe dry winters prevail. The States of Kansas, Nebraska, and Oklahoma lead in its production. More than 18,000,000 acres of this class of wheat are grown annually in the United States and comprise nearly one-third of the total wheat acreage. In 1919, as shown in Table 40, the acreage was almost 21,000,000 acres. In Figure 6 is shown the distribution of hard red winter wheat in 1919. Twelve varieties of hard red winter wheat are grown commercially in the United States, but these are known by about 40 different names. Several of the varieties are very similar in appearance.

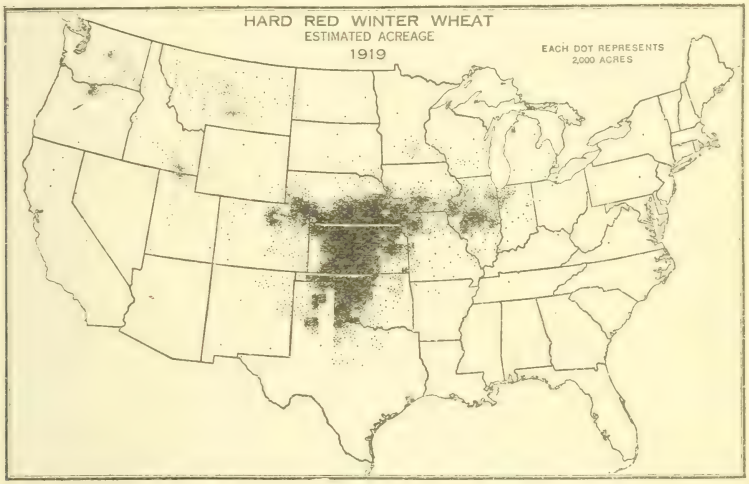


FIG. 6.—Distribution of wheat of the Hard Red Winter class.

Several additional varieties of hard red winter wheat which are not yet commercially grown are grown in experiments. A summary of the milling and baking results obtained from the principal commercial varieties and certain strains grown only in experiments are shown in Table 41. The States from which the samples were obtained are shown in Table 42.

TABLE 40.—*Estimated acreage of hard red winter wheat, 1919.*

State.	Acres.	State.	Acres.
Kansas	9,372,000	Missouri	588,800
Nebraska	3,504,900	Montana	370,000
Oklahoma	3,252,100	Washington	190,400
Illinois	1,103,400	Other States	885,400
Colorado	884,300		
Iowa	777,600	United States	21,677,900
Texas	749,000		

[9] For more complete information concerning the varieties and adaptation of hard red winter wheat, see Clark, J. Allen, and Martin, John H.: The Hard Red Winter Wheats, U. S. Dept. Agr. Farmers' Bul. 1280, 1922.

As with the previous classes, the varieties of hard red winter wheat are arranged in alphabetical order without regard to the number of samples milled or the importance of the varieties. The principal varieties grown are the Turkey and Kharkof. These are similar or nearly identical varieties. The Kharkof differs from Turkey, if at all, only in being slightly more winter hardy and in having slightly higher average acre yields in some sections. The Kharkof variety has been grown at most experiment stations in comparison with other hard red winter wheats, and for this reason, as well as because of its commercial importance and wide adaptation, it is used as a standard in this bulletin for comparing the other varieties of hard red winter wheat. Where samples of Kharkof have been obtained with other varieties grown under the same conditions tables showing the comparable data are presented to supplement the data shown in Table 41. In a very few cases Turkey has been substituted for Kharkof in the comparable tables in order to add to the number of the samples that can be compared. As Turkey and Kharkof are practically identical in milling value, this practice seems justified.

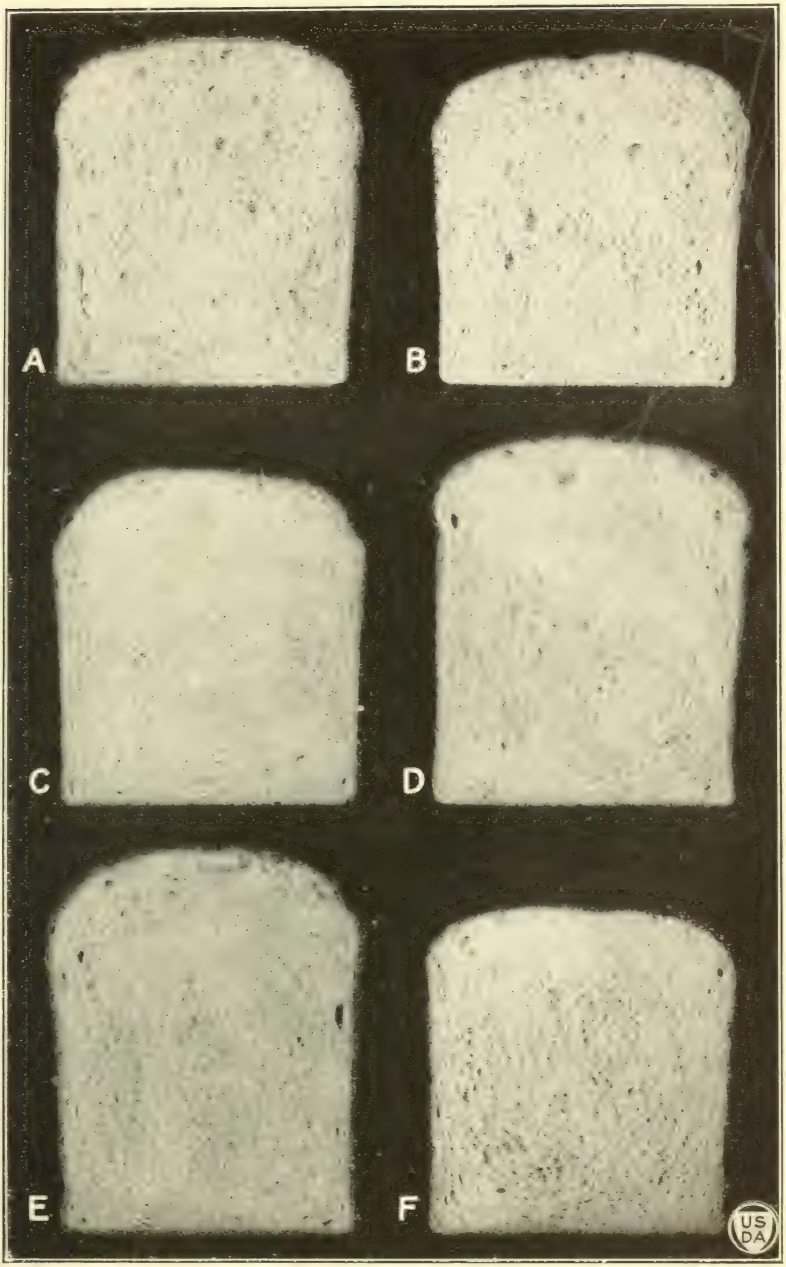
The varieties of hard red winter wheat shown in Table 41 are discussed separately in alphabetical order. Illustrations showing the relative differences in the quality of bread made from some of the principal varieties of this class are found in Plate III.

TABLE 41.—*Summary of milling and baking data on hard red winter wheat varieties grown during the seven years from 1915 to 1921, inclusive.*

Variety.	Number of samples.[1]	Test weight per bushel.		Crude protein of wheat.	Milling yields.			Baking results.					Ash in flour.
		Dockage-free.	Mill-cleaned.		Straight flour.	Shorts.	Bran.	Water absorption of flour.	Loaf.				
									Volume.	Weight.	Texture.	Color.	
		Lbs.	*Lbs.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*C. c.*	*Gms.*	*Score.*	*Score.*	*P. ct.*
Altara	6	60.5	61.9	14.2	71.1	13.0	15.9	61.7	2,008	507	90.9	92.6	0.43
Alton	8	58.3	60.6	16.0	73.2	11.3	15.5	61.1	1,961	506	89.2	90.3	.44
Blackhull	14	59.7	61.0	13.6	71.2	12.2	16.6	59.4	1,971	500	88.9	91.5	.41
Kanred	45	58.5	60.0	14.1	73.1	12.7	14.2	61.1	2,006	505	89.7	89.8	.46
Karmont	7	58.8	60.4	14.7	70.5	13.0	16.5	62.5	1,974	509	89.9	91.7	.41
Kharkof	77	58.9	60.3	14.0	71.6	14.1	14.3	61.9	2,019	503	89.5	90.9	.46
Minturki	10	58.6	60.2	14.1	70.7	11.3	18.0	56.2	2,196	490	90.4	88.9	.40
Montana No. 36	7	59.3	60.5	15.2	72.1	12.5	15.4	63.2	1,959	512	89.1	91.6	.44
Nebraska No. 6	5	59.4	61.3	12.6	72.1	12.1	15.8	60.3	2,056	503	91.1	91.2	.44
Nebraska No. 60	8	59.9	61.7	12.9	71.7	12.3	16.0	59.4	1,992	502	90.9	91.9	.42
"Station Red"	5	61.7	63.0	13.2	73.1	12.6	14.3	63.0	1,914	514	90.1	90.1	.48
Turkey	142	59.9	61.9	12.5	72.9	13.3	13.8	61.2	2,048	500	89.2	89.5	.46
Average of varietal samples (Max. No. 334)		59.4	61.1	13.5	72.4	13.1	14.5	61.1	2,028	502	89.5	90.2	.45
Average of class[2] (Max. No. 728)		58.8	.....	12.6	72 0.	13.1	14.9	60.0	2,121	497	90.3	90.4	.46

[1] This column contains the maximum number of samples used for each variety. In some instances, particularly for the factors of loaf color and ash, the results given represent the average of a fewer number of samples for the reason that complete data on all the samples were not available. The number of samples used for the various factors is given in Figures No. 12 to 23, inclusive.

[2] Average of all hard red winter wheat samples on which tests were made, including the varietal samples shown above.



LOAVES OF BREAD FROM SIX VARIETIES OF HARD RED WINTER WHEAT GROWN AT MANHATTAN, KANS., IN 1921.

The varieties, with the average loaf volumes, are as follows: *A*, Kharkof, 2,080 c. c.; *B*, Turkey, 1,950 c. c.; *C*, Kanred, 1,940 c. c.; *D*, Nebraska No. 60, 2,220 c. c.; *E*, Minturki, 2,310 c. c.; *F*, Blackhull, 1,970 c. c.

TABLE 42.—*Number of samples of each variety of hard red winter wheat grown in each State, the data on which are shown in Table 41.*

Variety.	Nebraska.	Oregon.	Wyoming.	Colorado.	Kansas.	Montana.	Washington.	South Dakota.	Idaho.	California.	Minnesota.	Utah.	North Dakota.	Texas.	Virginia.	Wisconsin.	Total.
Altara	....	1	1	1	3	....	....	....	....	....	....	....	....	....	....	....	6
Alton	....	....	4	4	....	....	....	....	....	....	....	....	....	....	....	....	8
Blackhull	....	1	2	2	5	2	1	....	....	....	....	1	....	....	....	....	14
Kanred	2	3	8	10	5	5	4	3	....	....	1	....	1	2	1	....	45
Karmont	....	....	1	1	2	3	....	....	....	....	....	....	....	....	....	....	7
Kharkof	4	9	10	9	5	8	3	11	1	7	....	5	3	1	....	1	77
Minturki	....	....	1	1	3	2	....	....	....	....	2	1	....	....	....	....	10
Montana No. 36	....	....	....	1	....	4	2	....	....	....	....	....	....	....	....	....	7
Nebraska No. 6	4	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	5
Nebraska No. 60	4	1	....	....	3	....	....	....	....	....	....	....	....	....	....	....	8
"Station Red"	....	....	....	....	1	1	3	....	....	....	....	....	....	....	....	....	5
Turkey	63	25	6	3	4	3	13	9	9	1	5	....	....	1	....	....	142
Total	77	40	33	32	32	28	26	23	10	8	8	7	4	4	1	1	334

Altara.—Altara (C. I. No. 5797) is a pure-line selection from a wheat called Alberta Red. The latter name was originally given to a lot of Turkey wheat by a milling company at Calgary, Alberta, Canada. This pure-line selection was made at the Kansas Agricultural Experiment Station. It is similar to Turkey, except that it has very hard, bright red kernels which are not usually subject to yellowberry. This was early observed at the Kansas station, where the strain has been grown for several years and from where it was distributed to other experiment stations. It is not grown commercially. In comparative experiments Altara has yielded less than most other hard red winter wheats.

Six samples of Altara have been milled and baked, and the results are summarized in Table 41. The samples were obtained from experiment stations in Kansas, Colorado, Wyoming, and Oregon during the two years 1920 and 1921. All of the samples can be directly compared with samples of Kharkof grown under similar conditions. This comparison is shown in Table 43. The results show Altara to have a heavy test weight per bushel, and a higher average flour yield, loaf volume, and color of loaf than Kharkof. In spite of its hard bright kernels, it has a considerably lower crude protein content than Kharkof and also is slightly lower in water absorption of flour.

TABLE 43.—*Summary of milling and baking data on six samples of Altara and six comparable samples of Kharkof grown during the two years 1920 and 1921.*

Descriptive data.	Altara.	Kharkof.	Percentage of Kharkof.
Number of samples	6	6	.....
Test weight per bushel (mill-cleaned wheat).....pounds..	61.9	60.2	102.8
Crude protein content of wheat.....per cent..	14.2	15.0	94.7
Yield of straight flour.....do....	71.1	70.5	100.9
Yield of shorts.....do....	13.0	13.2	98.5
Yield of bran.....do....	15.9	16.3	97.5
Water absorption of flour.....do....	61.7	62.3	99.0
Volume of loaf.....cubic centimeters..	2,008	1,957	102.6
Weight of loaf.....grams..	507	510	99.4
Texture of loaf.....score..	90.9	91.0	99.9
Color of loaf.....do....	92.6	92.3	100.3
Ash in flour.....per cent..	0.43	0.44	97.7

Alton (Ghirka Winter).—Alton, formerly known as Ghirka Winter, was introduced into the United States from Altonau, near Melitopal, northern Taurida, Russia, by the United States Department of Agriculture, in 1900. It was distributed to some extent, but its production has never become important. It is now commercially grown to a slight extent in Colorado, Kansas, and Wyoming. Alton differs from Turkey in having beardless spikes and shorter and softer kernels and a very small germ. The variety, however, is usually graded as a hard red winter wheat. Alton is best adapted to northeastern Colorado and southeastern Wyoming, but even there it yields less than Turkey, Kharkof, and Kanred.

Eight samples of the Alton variety have been milled and baked and the data are presented in Table 41. Seven of the samples are directly comparable with samples of Kharkof grown under the same conditions. The samples were obtained from experiment stations in Colorado and Wyoming during the five years 1916 to 1919, inclusive, and 1921. The comparable data are shown in Table 44. The results show the Alton variety to have a heavier test weight per bushel than Kharkof. In these experiments, however, it has averaged slightly less in crude protein and water absorption. It has exceeded Kharkof in yield of straight flour and in volume, weight, texture, and color of loaf. It also has a slightly lower ash in the flour. In these experiments the Alton has shown to be a very good milling and bread-making wheat in comparison with Kharkof, the standard hard red winter wheat variety, but it is not sufficiently productive to become of commercial importance.

TABLE 44.—*Summary of milling and baking data on seven samples of Alton and seven comparable samples of Kharkof grown during the five years from 1916 to 1919, inclusive, and 1921.*

Descriptive data.	Alton.	Kharkof.	Percentage of Kharkof.
Number of samples	7	7	
Test weight per bushel (mill-cleaned wheat).....pounds..	61.0	59.7	102.2
Crude protein content of wheat.....per cent..	16.0	16.3	98.2
Yield of straight flour.....do....	74.0	71.7	103.2
Yield of shorts.....do....	12.4	13.9	89.2
Yield of bran.....do....	13.6	14.4	94.4
Water absorption of flour.....do....	62.3	62.7	99.4
Volume of loaf.....cubic centimeters..	2,004	1,977	101.4
Weight of loaf.....grams..	507	506	100.2
Texture of loaf.....score..	88.4	88.3	100.1
Color of loaf.....do....	89.6	87.6	102.3
Ash in flour [1].....per cent..	0.45	0.46	97.8

[1] Average of 5 samples.

Blackhull.—The Blackhull variety, known also as Clark's Blackhulled and Black Chaff, was developed by Earl G. Clark from three heads found in a field of Turkey wheat near Sedgwick, Harvey County, Kans., in 1912. The variety was increased by Mr. Clarke and was first distributed in 1917. It has since become rather widely grown in Kansas, especially in the central part. It differs from Turkey or Kharkof in having black-striped or sometimes solid black outer glumes or chaff. Under some conditions the black color does not develop. It is slightly earlier than those varieties. Blackhull

has softer kernels than Turkey or Kharkof, but is usually less subject to yellowberry. It is graded as a hard red winter wheat. Blackhull yields about as well as Kanred in central Kansas. In other sections it usually is inferior to Kanred and sometimes to other varieties.

Fourteen samples of the Blackhull variety have been milled and baked and the average data are shown in Table 41. Thirteen of the samples are directly comparable with samples of Kharkof produced under the same conditions. A comparison of these results is shown in Table 45.

Experiments show Blackhull to have averaged slightly higher than Kharkof in test weight per bushel, but considerably less than Kharkof in crude protein content, and slightly less in yield of flour. It also has a somewhat higher yield of bran. In bread making it has a lower water absorption, and volume, weight, texture, and color of loaf. The ash in the flour has been found to be somewhat less than that of Kharkof. In milling it produces a broad bran and a somewhat whiter and softer flour than other hard red winter wheats. In general, Blackhull is slightly inferior in milling and baking value to Kharkof and other similar varieties of hard red winter wheat.

TABLE 45.—*Summary of milling and baking data on 13 samples of Blackhull and 13 comparable samples of Kharkof grown in the two years 1920 and 1921.*

Descriptive data.	Blackhull.	Kharkof.	Percentage of Kharkof.
Number of samples	13	13	
Test weight per bushel (mill-cleaned wheat) ..... pounds..	60.8	60.1	101.2
Crude protein content of wheat ..... per cent..	13.7	14.2	96.5
Yield of straight flour ..... do....	70.8	71.0	99.7
Yield of shorts ..... do....	12.1	12.7	95.3
Yield of bran ..... do....	17.1	16.3	104.9
Water absorption of flour ..... do....	59.5	62.2	95.7
Volume of loaf ..... cubic centimeters..	1,951	1,993	97.9
Weight of loaf ..... grams..	501	507	98.8
Texture of loaf ..... score..	88.8	89.9	98.8
Color of loaf ..... do....	91.4	91.6	99.8
Ash in flour ..... per cent..	0.41	0.44	93.2

Kanred.—Kanred wheat was developed at the Kansas Agricultural Experiment Station by selection from the Crimean variety, which had been introduced into the United States from Russia in 1900. Kanred was widely distributed throughout Kansas by the Kansas Agricultural Experiment Station in the fall of 1917. In 1921 it was estimated that more than 2,000,000 acres of the variety were grown. Kanred differs from Turkey and Kharkof in being resistant to some forms of stem and leaf rust and in having longer beards or beaks on the outer glumes. It outyields Turkey and Kharkof in Kansas, Nebraska, Oklahoma, Colorado, Wyoming, and Texas, and is fully equal to those varieties in other States.

Forty-five samples of Kanred wheat, some of which are from commercial sources, have been milled and baked, as shown in Table 41. Thirty-two of these samples may be compared directly with samples of Kharkof, as both were grown under similar conditions at experiment stations in the hard winter wheat sections of Kansas,

Texas, Colorado, Nebraska, South Dakota, North Dakota, Wyoming, Montana, Washington, and Oregon, representing the five crop years 1917 to 1921, inclusive. These comparable data are shown in Table 46.

The data show Kanred to be equal to Kharkof in test weight per bushel and to average only slightly lower in crude protein content. Kanred produces a higher yield of flour and less shorts and bran. It has averaged slightly lower in water absorption and volume and weight of loaf, but the differences are so slight that they are not significant. It has a considerably lower ash in the flour. In these experiments the Kanred variety has proved to be practically equal to Kharkof in milling and bread-making value. Because of its high acre yields, the production of Kanred should be considerably increased.

TABLE 46.—*Summary of milling and baking data on 32 samples of Kanred and 32 comparable samples of Kharkof grown during the five years from 1917 to 1921, inclusive.*

Descriptive data.	Kanred.	Kharkof.	Percentage of Kharkof.
Number of samples	32	32	
Test weight per bushel (mill-cleaned wheat)...pounds..	60.1	60.1	100.0
Crude protein content of wheat...per cent..	14.1	14.3	98.6
Yield of straight flour...do....	73.4	72.0	101.9
Yield of shorts...do....	12.3	13.1	93.9
Yield of bran...do....	14.3	14.9	96.0
Water absorption of flour...do....	61.0	62.0	98.4
Volume of loaf...cubic centimeters..	1,987	1,997	99.5
Weight of loaf...grams..	504	506	99.6
Texture of loaf...score..	89.5	89.4	100.1
Color of loaf...do....	89.4	89.3	100.1
Ash in flour...per cent..	0.45	0.48	93.8

Karmont.—The Karmont variety is a high-yielding selection of Kharkof wheat developed at the Judith Basin substation, Moccasin, Mont. The selection was made in 1911 by E. L. Adams, of the United States Department of Agriculture. It is identical with Turkey and Kharkof in appearance. In experiments at Moccasin since 1918, it has significantly outyielded all other hard red winter wheats. Seed was distributed to other experiment stations and increased for commercial growing in the fall of 1920. Karmont has not outyielded Kharkof outside of Montana. Seven samples of the Karmont variety have been milled and baked. The data are shown in Tables 41 and 47, where a comparison is made with a similar number of Kharkof samples grown under the same conditions. The samples were obtained from experiment stations in Montana, Kansas, Wyoming, and Colorado during the two years 1920 and 1921.

The data show Karmont to equal Kharkof in test weight per bushel, but to average slightly lower in crude protein and in yield of straight flour. It has averaged slightly higher in water absorption and in weight, texture, and color of loaf, but slightly lower in loaf volume. In ash in flour it has averaged less than Kharkof. In general, the differences between the two strains are not significant, and the experiments indicate that Karmont is equal to Kharkof in milling and baking value.

TABLE 47.—*Summary of milling and baking data on seven samples of Karmont and seven comparable samples of Kharkof grown in the two years 1920 and 1921.*

Descriptive data.	Karmont.	Kharkof.	Percentage of Kharkof.
Number of samples	7	7	
Test weight per bushel (mill-cleaned wheat)....pounds..	60.4	60.4	100.0
Crude protein content of wheat....per cent..	14.7	15.3	96.1
Yield of straight flour....do....	70.5	71.4	98.7
Yield of shorts....do....	13.0	13.3	97.7
Yield of bran....do....	16.5	15.3	107.8
Water absorption of flour....do....	62.5	62.1	100.6
Volume of loaf....cubic centimeters..	1,974	1,983	99.5
Weight of loaf....grams..	509	507	100.4
Texture of loaf....score..	89.9	89.0	101.0
Color of loaf....do....	91.7	91.0	100.8
Ash in flour [1]....per cent..	0.41	0.43	95.3

[1] Average of 6 samples.

Kharkof.—The Kharkof variety was introduced into the United States from Russia in 1900 by the United States Department of Agriculture. It was obtained from the Kharkof Government, which is north of the section in which Turkey wheat is grown. Although similar to Turkey in appearance, it was thought that the Kharkof variety would be more winter-hardy than Turkey. During the early years of its culture in the United States this appeared to be the case, but in recent years very little difference in hardiness and yield has been observed. Kharkof wheat was widely distributed by the United States Department of Agriculture and several State experiment stations in the years immediately following 1900. It is now widely grown in the hard winter wheat producing sections.

Seventy-seven samples of Kharkof have been milled and baked, and the data are presented in Table 41. Most of these samples were obtained from experiment stations in the western half of the United States. The variety is used in this bulletin as a basis for comparing quality of hard red winter wheat varieties. These comparisons are shown in Tables 43 to 54, inclusive.

Minturki.—The Minturki variety originated from a cross between Turkey and Odessa, made at the Minnesota Agricultural Experiment Station in 1902. On account of its winter hardiness the variety was increased and distributed for commecial growing in Minnesota in 1919. When grown under dry conditions the kernels of Minturki wheat are softer than those of Turkey, Kharkof, or Kanred, but aside from this and its greater hardiness Minturki does not differ greatly from those varieties. Under the humid conditions of Minnesota the kernels of Minturki are as hard as other hard red winter varieties. It is properly graded, therefore, as hard red winter wheat. Minturki outyields Turkey, Kharkof, and Kanred in Minnesota partly because of its hardiness, but it is less productive than these varieties in other States.

Ten samples of Minturki have been milled and baked, and the data are presented in Tables 41 and 48. In the latter table comparison is made with samples of Kharkof grown under similar conditions. These samples were obtained from experiment stations in Minnesota, Kansas, Colorado, Wyoming, Utah, and Montana during the two years 1920 and 1924. The data show Minturki to average slightly

lower in test weight per bushel, crude protein content, and yield of flour than Kharkof. In the bread-making experiments it has averaged considerably lower in water absorption of flour and in weight and color of loaf, but has exceeded Kharkof in volume and texture of loaf. It also has a lower ash in the flour. While in these experiments Minturki is somewhat poorer than Kharkof in milling value, it has shown superior comparative baking qualities.

TABLE 48.—*Summary of milling and baking data on ten samples of Minturki and ten comparable samples of Kharkof grown in the two years 1920 and 1921.*

Descriptive data.	Minturki.	Kharkof.	Percentage of Kharkof.
Number of samples	10	10	
Test weight per bushel (mill-cleaned wheat)...pounds..	60.2	60.7	99.2
Crude protein of wheat...per cent..	14.1	14.4	97.9
Yield of straight flour...do....	70.7	71.5	98.9
Yield of shorts...do....	11.3	12.8	88.3
Yield of bran...do....	18.0	15.7	114.6
Water absorption of flour...do....	56.2	61.4	91.5
Volume of loaf...cubic centimeters..	2,196	2,025	108.4
Weight of loaf...grams..	490	505	97.0
Texture of loaf...score..	90.4	89.4	101.1
Color of loaf...do....	88.9	91.3	97.4
Ash in flour...per cent..	0.40	0.46	87.0

Montana No. 36.—Montana No. 36 is identical with Kharkof in all observable characters. It was selected from that variety at the Montana Agricultural Experiment Station, Bozeman, Mont., from which station it was distributed in 1915. The wheat has since been grown to a considerable extent in Montana and experimentally in other States. It yields about the same as the original Kharkof.

Seven samples of Montana No. 36 have been milled and baked. The data are presented in Tables 41 and 49. The samples were obtained from experiment stations in Montana, Colorado, and Washington during the two years 1920 and 1921. The comparison of this variety with Kharkof shows that the two are practically indentical in milling value, the principal differences being that Montana No. 36 has a somewhat higher crude protein content and higher water absorption. The other slight differences obtained are not significant. In general, it may be said that the two varieties are identical in milling value.

TABLE 49.—*Summary of milling and baking data on seven samples of Montana No. 36 and seven comparable samples of Kharkof grown in the two years 1920 and 1921.*

Descriptive data.	Montana No. 36.	Kharkof.	Percentage of Kharkof.
Number of samples	7	7	
Test weight per bushel (mill-cleaned wheat)...pounds..	60.5	60.6	99.8
Crude protein content of wheat...per cent..	15.2	14.7	103.4
Yield of straight flour...do....	72.1	72.0	100.1
Yield of shorts...do....	12.5	13.4	93.3
Yield of bran...do....	15.4	14.6	105.5
Water absorption of flour...do....	63.2	62.1	101.8
Volume of loaf...cubic centimeters..	1,959	1,953	100.3
Weight of loaf...grams..	512	508	100.8
Texture of loaf...score..	89.1	88.7	100.5
Color of loaf...do....	91.6	90.9	100.8
Ash in flour...per cent..	0.44	0.45	97.8

Nebraska No. 6.—Nebraska No. 6 is a selection of Turkey made at the Nebraska Agricultural Experiment Station, from which it was distributed in 1918. This strain is now grown commercially to a considerable extent in Nebraska. It is very similar to the original Turkey but outyields it in Nebraska.

Five samples of Nebraska No. 6 have been milled and baked. The data are presented in Tables 41 and 50. In the latter table the results are compared with similar samples of Kharkof grown under the same conditions at experiment stations in Nebraska and Kansas during the four years 1916, 1917, 1918, and 1921.

The data show Nebraska No. 6 to be slightly higher in crude protein content, but lower in yield of flour than Kharkof. In the baking experiments it has averaged slightly lower in water absorption of flour and weight of loaf, but slightly higher in volume, texture, and color of loaf. It also has a higher ash in the flour. In these experiments Nebraska No. 6 has proved to be not quite equal to Kharkof in milling qualities but slightly superior in bread-making qualities.

TABLE 50.—*Summary of milling and baking data on five samples of Nebraska No. 6 and five comparable samples of Kharkof grown during the four years from 1916 to 1918, inclusive, and 1921.*

Descriptive data.	Nebraska No. 6.	Kharkof.	Percentage of Kharkof.
Number of samples	5	5	
Test weight per bushel (mill-cleaned wheat)....pounds..	61.3	61.1	100.3
Crude protein content of wheat....per cent..	12.6	12.3	102.4
Yield of straight flour....do....	72.1	73.6	98.0
Yield of shorts....do....	12.1	11.9	101.7
Yield of bran....do....	15.8	14.4	109.7
Water absorption of flour....do....	60.3	61.0	98.9
Volume of loaf....cubic centimeters..	2,056	1,984	103.6
Weight of loaf....grams..	503	506	99.4
Texture of loaf....score..	91.1	89.1	102.2
Color of loaf....do....	91.2	90.9	100.3
Ash in flour....per cent..	0.44	0.42	104.8

Nebraska No. 60.—Nebraska No. 60 wheat is also identical with Turkey in appearance. Like Nebraska No. 6, it was selected from the Turkey variety at the Nebraska Agricultural Experiment Station and was distributed for commercial growing in 1918. In Nebraska, Nebraska No. 60 is a slightly better yielding strain than Nebraska No. 6, and is more widely grown commercially, but does not outyield Kanred.

Eight samples of Nebraska No. 60 have been milled and baked. The data are presented in Tables 41 and 51. In these experiments, it has proved to be very similar to Kharkof, differing only in having a slightly lower crude protein content and water absorption of flour and a slightly higher volume and texture of loaf.

TABLE 51.—*Summary of milling and baking data on eight samples of Nebraska No. 60 and eight comparable samples of Kharkof grown during the four years from 1916 to 1918, inclusive, and 1921.*

Descriptive data.	Nebraska No. 60.	Kharkof.	Percentage of Kharkof.
Number of samples	8	8	
Test weight per bushel (mill-cleaned wheat)....pounds..	61.7	60.8	101.5
Crude protein content of wheat....per cent..	12.9	13.0	99.2
Yield of straight flour....do....	71.7	71.9	99.7
Yield of shorts....do....	12.3	12.3	100.0
Yield of bran....do....	16.0	15.8	101.3
Water absorption of flour....do....	59.4	61.0	97.4
Volume of loaf....cubic centimeters..	1,992	1,963	101.5
Weight of loaf....grams..	502	507	99.0
Texture of loaf....score..	90.9	89.8	101.2
Color of loaf....do....	91.9	91.7	100.2
Ash in flour....per cent..	0.42	0.42	100.0

"Station Red."—"Station Red" is a crossbred wheat developed at the Washington State College, Pullman, Wash. It is a result of a combination of crosses, having Turkey, Jones Fife, and Pacific Bluestem in its parentage. It is similar to Turkey in appearance but has weaker straw. It has shown considerable promise as a winter-hardy, high-yielding strain in experiments at the Adams County Branch Station, Lind, Wash., and is now being tested at other experiment stations. The variety has not yet been officially named, nor has it been increased or distributed for commercial growing.

Five samples of this strain of wheat have been milled and baked. The data are presented in Tables 41 and 52. The samples were obtained from the experiment stations in Washington, Montana, and Kansas during the two years 1920 and 1921. The data show "Station Red" to exceed Kharkof in test weight per bushel and yield of flour. It averages slightly less in crude protein but exceeds Kharkof in water absorption of flour and in volume, weight, and texture of loaf. The results indicate that "Station Red" is equal or superior to the Kharkof variety in milling and bread-making qualities.

TABLE 52.—*Summary of milling and baking data on five samples of "Station Red" and five comparable samples of Kharkof grown in the two years 1920 and 1921.*

Descriptive data.	"Station Red."	Kharkof.	Percentage of Kharkof.
Number of samples	5	5	
Test weight per bushel (mill-cleaned wheat)....pounds..	63.0	61.7	102.1
Crude protein content of wheat....per cent..	13.2	14.0	94.3
Yield of straight flour....do....	73.1	72.4	101.0
Yield of shorts....do....	12.5	13.9	89.9
Yield of bran....do....	14.3	13.7	104.4
Water absorption of flour....do....	63.0	61.9	101.8
Volume of loaf....cubic centimeters..	1,914	1,892	101.2
Weight of loaf....grams..	514	509	101.0
Texture of loaf....score..	90.1	90.0	100.1
Color of loaf....do....	90.1	90.1	100.0
Ash in flour....per cent..	0.48	0.47	102.1

Turkey.—The Turkey variety was introduced into the United States by Mennonite immigrants from Russia about 1873. To-day it is the most widely grown variety of wheat in the United States. It has awned spikes, glabrous white glumes, and slender stems.

Turkey is practically identical with Kharkof in yield, hardiness, and appearance.

One hundred and forty-two samples of Turkey wheat have been milled and baked during the seven years from 1915 to 1921, inclusive. Most of these samples are of commercial origin, coming from the principal hard winter wheat districts of the United States. These data are shown in Table 41. Only 22 of the samples can be directly compared with the samples of Kharkof grown under the same conditions. They were obtained from experiment stations in Kansas, Colorado, Wyoming, Montana, Nebraska, South Dakota, Oregon, and Washington during the seven years 1915 to 1921, inclusive. These data are shown in Table 53.

In these experiments it is shown that Turkey and Kharkof are practically identical in milling and bread-making values. Turkey has averaged slightly lower than Kharkof in crude protein content and in water absorption of flour. It has slightly exceeded Kharkof in volume and texture of loaf. In general, the two varieties are similar in milling and bread-making qualities.

TABLE 53.—*Summary of milling and baking data on 22 samples of Turkey and 22 comparable samples of Kharkof grown during the seven years from 1915 to 1921, inclusive.*

Descriptive data.	Turkey.	Kharkof.	Percentage of Kharkof.
Number of samples	22	22	
Test weight per bushel (mill-cleaned wheat)...pounds..	60.9	60.5	100.7
Crude protein content of wheat...per cent..	13.9	14.3	97.2
Yield of straight flour...do....	72.0	71.6	100.6
Yield of shorts...do....	13.2	13.5	97.8
Yield of bran...do....	14.8	14.9	99.3
Water absorption of flour...do....	61.9	62.5	99.0
Volume of loaf...cubic centimeters..	2,062	2,028	101.7
Weight of loaf...grams..	506	506	100.0
Texture of loaf...score..	90.2	89.0	101.3
Color of loaf...do....	90.2	90.7	99.4
Ash in flour [1]...per cent..	0.44	0.45	97.8

[1] Average of 16 samples.

SUMMARY OF THE MILLING AND BAKING DATA ON THE VARIETIES OF HARD RED WINTER WHEAT.

The milling and baking data on the varieties of hard red winter wheat shown in Tables 43 to 53, inclusive, are summarized in Table 54 and shown graphically in Figure 7, the data being expressed in percentages of Kharkof. The differences in the varieties are relatively small. Minturki has the highest loaf volume, but is lowest in test weight per bushel, water absorption of flour, and weight and color of loaf. It also has the lowest ash content.

Montana No. 36 and Nebraska No. 6 have the highest protein content, while "Station Red" and Altara are lowest. The relative percentage of straight flour is about the same for all varieties, although Alton and Kanred are highest in this respect. All of the varieties are satisfactory for milling and bread making, although Blackhull, Minturki, and Alton are softer wheats and in some respects somewhat inferior to the others. The three leading varieties of hard red winter wheat—Turkey, Kharkof, and Kanred—are practically equal in milling and baking value.

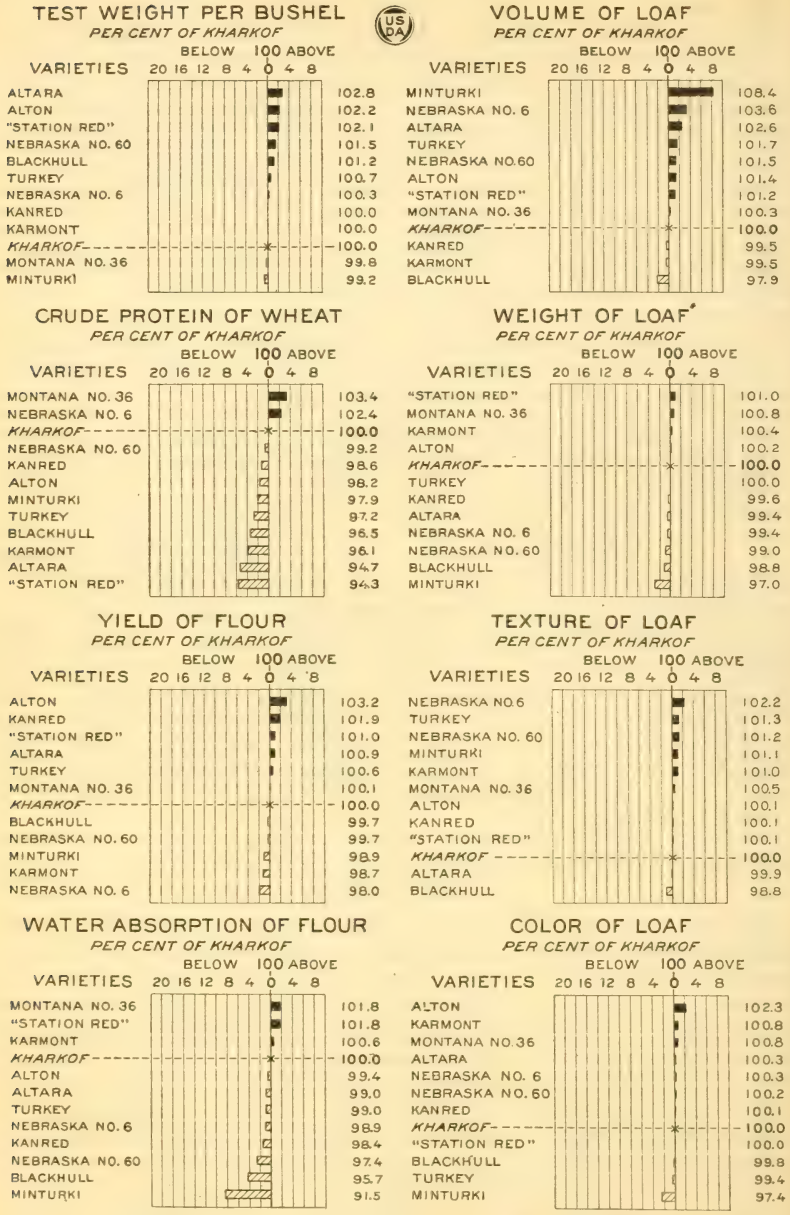


FIG. 7.—A comparison of the milling and baking data, in percentage of Kharkof, from samples of each of 11 other varieties of Hard Red Winter wheat grown under comparable conditions with Kharkof. (Data from Table 51.)

TABLE 54.—*Summary of milling and baking data, in percentage of Kharkof, on comparable samples of 11 other varieties of hard red winter wheat grown during one or more of the seven years from 1915 to 1921, inclusive.*

Variety.	Test weight per bushel (mill-cleaned).	Crude protein of wheat.	Milling yields.			Water absorption of flour.	Volume of loaf.	Weight of loaf.	Texture of loaf.	Color of loaf.	Ash in flour.
			Straight flour.	Shorts.	Bran.						
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Kharkof	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Altara	102.8	94.7	100.9	98.5	97.5	99.0	102.6	99.4	99.9	100.3	97.7
Alton	102.2	98.2	103.2	89.2	94.4	99.4	101.4	100.2	100.1	102.3	97.8
Blackhull	101.2	96.5	99.7	95.3	104.9	95.7	97.9	98.8	98.8	99.8	93.2
Kanred	100.0	98.6	101.9	93.9	96.0	98.4	99.5	99.6	100.1	100.1	93.8
Karmont	100.0	96.1	98.7	97.7	107.8	100.6	99.5	100.4	101.0	100.8	95.3
Minturki	99.2	97.9	98.9	88.3	114.6	91.5	108.4	97.0	101.1	97.4	87.9
Montana No. 36	99.8	103.4	100.1	93.3	105.5	101.8	100.3	100.8	100.5	100.8	97.8
Nebraska No. 6	100.3	102.4	98.0	101.7	109.7	98.9	103.6	99.4	102.2	100.3	104.8
Nebraska No. 60	101.5	99.2	99.7	100.0	101.3	97.4	101.5	99.0	101.2	100.2	100.0
"Station Red"	102.1	94.3	101.0	89.9	104.4	101.8	101.2	101.0	100.1	100.0	102.1
Turkey	100.7	97.2	100.6	97.8	99.3	99.0	101.7	100.0	101.3	99.4	97.8

THE SOFT RED WINTER WHEATS.[10]

The commercial class of wheat known as soft red winter, in which are included all the varieties of soft red winter common wheats and the red kerneled club varieties, is largely grown in the humid sections of the eastern half of the United States. The States leading in its

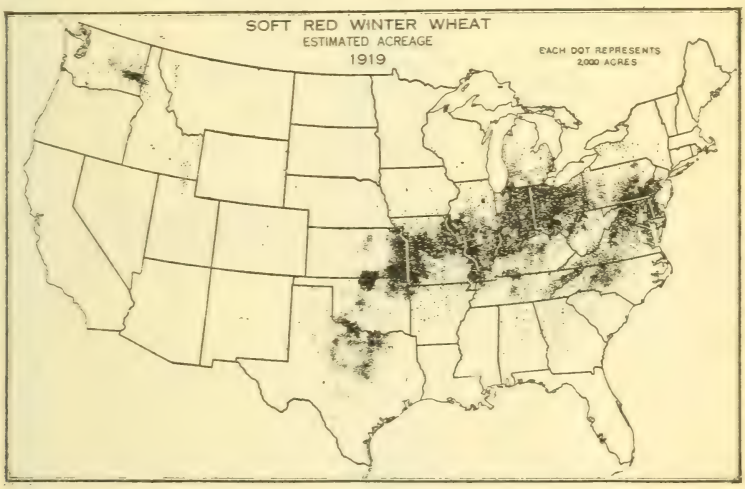


FIG. 8.—Distribution of wheat of the Soft Red Winter class.

production are Missouri, Indiana, Ohio, and Illinois. About 16,000,000 acres of this class of wheat are grown annually in the United States, comprising over 30 per cent of the total wheat acreage. In 1919, as shown in Table 55, the acreage was almost 21,000,000. The distribution of soft red winter wheat in the United States in 1919 is shown in Figure 8.

[10] For more complete information on the varieties and adaptation of soft red winter wheat, see Leighty, Clyde E.: Varieties of Winter Wheat Adapted to the Eastern United States. U. S. Dept. Agr. Farmers' Bul. 1168, 1921; and Leighty, Clyde E., and Martin, John H.: The Soft Red Winter Wheats. U. S. Dept. Agr. Farmers' Bul. 1305.

TABLE 55.—*Estimated acreage of soft red winter wheat, 1919.*

State.	Acres.	State.	Acres.
Missouri	3,461,700	Oklahoma	1,056,700
Indiana	2,354,500	Virginia	887,400
Ohio	2,250,800	Kentucky	737,300
Illinois	2,153,400	Other States	3,704,500
Texas	1,488,500		
Kansas	1,424,300	United States	20,691,400
Pennsylvania	1,172,300		

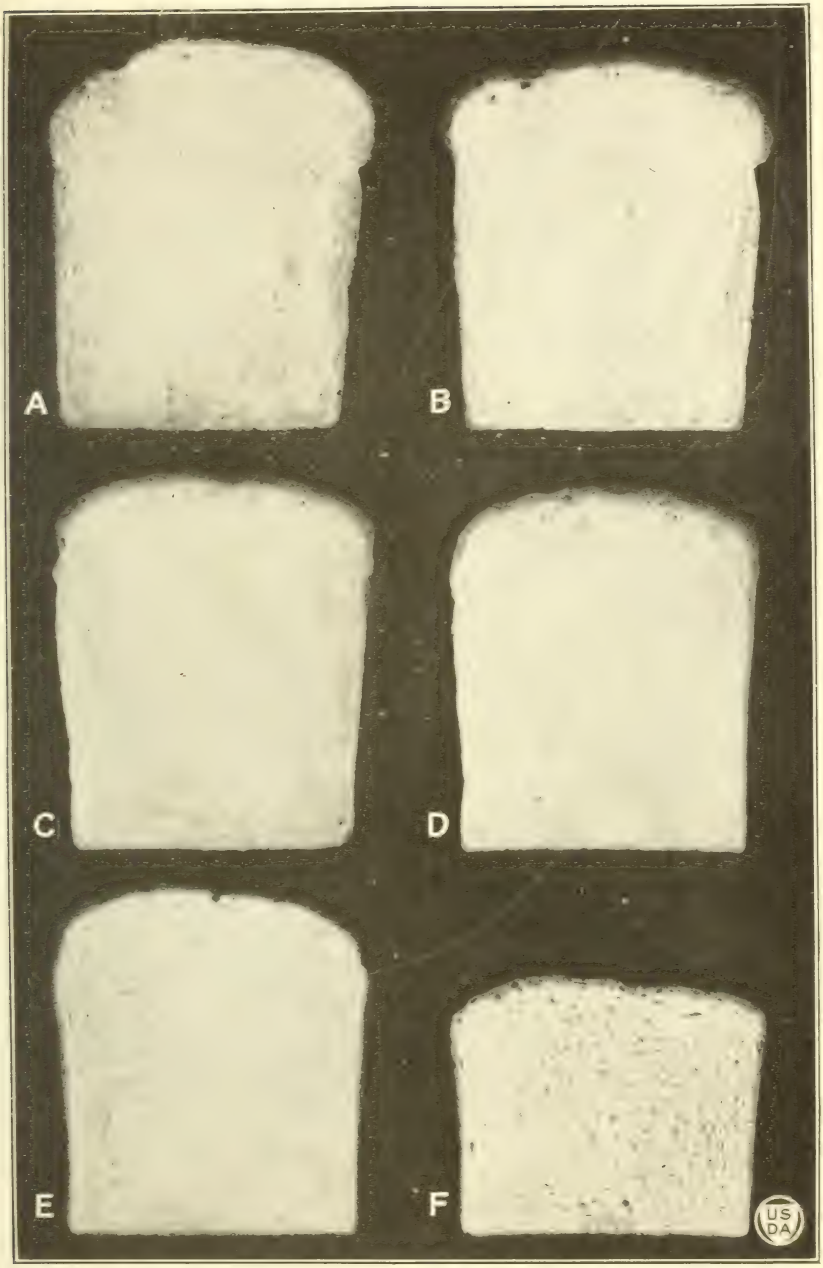
About 65 varieties of soft red winter wheats are grown. Many of these varieties have not been milled and baked, but of several of them less than five samples have been tested and are therefore not included in this bulletin. Fifteen of the varieties have been sufficiently tested to warrant presenting the results here. The data are presented in Table 56, and the States from which the samples were obtained are named in Table 57. Most of the samples of these varieties were obtained from commercial sources. The few samples obtained from experiment stations were not grown in comparison with a standard variety of the class. It is not possible, therefore, to compare samples of any of the varieties in this class with a standard or leading variety. The only milling and baking data available from which the respective quality of the various varieties may be judged are, therefore, the results of the total number of samples tested. As with previous classes, the varieties are discussed separately and in alphabetical order. Illustrations showing the relative differences in the quality of bread made from some of the principal varieties of this class are found in Plate IV.

TABLE 56.—*Summary of milling and baking data on soft red winter wheat varieties grown during the seven years from 1915 to 1921, inclusive.*

Variety.	Number of samples.[1]	Test weight per bushel.		Crude protein of wheat.	Milling yields.			Baking results.					Ash in flour.
		Dockage-free.	Mill-cleaned.		Straight flour.	Shorts.	Bran.	Water absorp- of flour.	Loaf.				
									Volume.	Weight.	Texture.	Color.	
		Lbs.	*Lbs.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*C. c.*	*Gms.*	*Score.*	*Score.*	*P. ct.*
Common wheats:													
Buffum No. 17	7	57.1	58.6	14.7	71.1	12.1	16.8	57.5	2,020	496	85.7	86.0	.46
Currell	6	60.1	61.8	10.8	74.9	12.5	12.6	53.9	1,937	474	88.9	86.4	.44
Fulcaster	23	59.3	60.9	12.5	71.5	14.4	14.1	57.8	2,039	487	91.1	91.1	.47
Fultz	10	58.5	60.9	11.2	72.0	12.4	15.6	56.6	2,033	485	87.2	89.5	.44
Huston	6	61.0	62.7	10.1	71.8	15.9	12.3	57.7	1,880	491	87.4	89.2	.65
Jones Fife	26	57.5	59.2	11.6	69.2	15.0	15.8	54.5	1,621	475	80.9	88.4	.45
Kinney	6	61.8	64.3	9.2	73.7	14.1	12.2	55.8	1,795	476	90.6	89.4	.54
Mediterranean	5	58.9	60.5	11.8	72.9	13.0	14.1	56.9	2,000	492	88.2	91.4	.47
Minhardi	7	58.1	59.5	14.2	69.8	13.8	16.4	55.7	2,147	488	88.7	88.6	.42
Odessa	6	58.4	59.0	11.4	73.7	11.7	14.6	55.0	2,175	487	87.7	88.2	.41
Purplestraw	6	58.2	59.8	11.5	73.3	13.1	13.6	55.7	2,165	487	91.9	90.6	.47
Red Rock	30	60.8	60.9	11.0	70.9	13.9	15.2	58.4	2,245	492	91.9	93.2	.50
Red Russian	30	57.5	60.1	9.5	71.5	13.9	14.6	53.6	1,667	469	84.6	87.9	.41
Triplet	11	59.2	60.4	12.6	67.3	14.5	18.2	57.9	1,869	498	88.5	89.6	.42
Club wheat:													
Hybrid 123	10	59.3	60.9	10.0	69.3	14.0	16.7	55.9	1,833	484	88.7	87.0	.43
Average of varietal samples (Max. No. 189)		58.9	60.5	11.3	71.0	13.9	15.1	56.1	1,929	484	87.7	89.6	.46
Average of class[2] (Max. No. 457)		58.6	.....	11.3	71.1	13.5	15.4	55.9	2,001	489	88.9	89.1	.46

[1] This column contains the maximum number of samples used for each variety. In some instances, particularly for the factors of loaf color and ash, the results given represent the average of a fewer number of samples for the reason that complete data on all the samples were not available. The number of samples used for the various factors is given in Figures Nos. 12 to 23, inclusive.

[2] Averages of all soft red winter wheat samples on which tests were made, including the varietal samples shown above.



LOAVES OF BREAD FROM SIX VARIETIES OF SOFT RED WINTER WHEAT.

The varieties, with source of grain and average loaf volumes, are as follows: From Arlington Farm, Rosslyn, Va., 1919 crop: *A*, Red Rock, 2,520 c. c.; *B*, Fultz, 2,350 c. c.; *C*, Purplestem, 2,300 c. c.; *D*, Fulcaster, 2,180 c. c.; from Lind, Wash., 1920 crop: *E*, Triplet, 2,020 c. c.; *F*, Jones Fife, 1,570 c. c.

TABLE 57.—*Number of samples of each variety of soft red winter wheat grown in each State, the data on which are shown in Table 56.*

Variety.	Washington.	Oregon.	Virginia.	Michigan.	Idaho.	Minnesota.	Montana.	Kansas.	New York.	Oklahoma.	Utah.	Maryland.	California.	Colorado.	Pennsylvania.	Texas.	North Dakota.	Ohio.	Wyoming.	Total.
Common wheats:																				
Buffum No. 17	....	....	....	....	....	2	2	....	....	....	....	....	....	1	....	....	1	....	1	7
Currell	....	....	3	....	....	....	....	....	....	....	....	3	....	....	....	....	....	....	....	6
Fulcaster	....	1	12	....	....	....	....	1	4	3	....	....	....	....	....	2	....	....	....	23
Fultz	1	....	6	....	....	....	....	1	....	1	....	....	....	1	....	....	....	....	....	10
Huston	....	6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	6
Jones Fife	18	5	2	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	26
Kinney	....	6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	6
Mediterranean	....	....	5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5
Minhardi	....	....	....	....	....	2	3	2	....	....	....	....	....	....	....	....	....	....	....	7
Odessa	....	....	....	....	....	2	....	....	....	....	4	....	....	....	....	....	....	....	....	6
Purplestraw	....	....	6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	6
Red Rock	....	....	1	25	....	1	....	....	....	....	....	....	....	....	2	....	....	1	....	30
Red Russian	12	13	....	....	5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	30
Triplet	6	4	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	11
Club wheats:																				
Hybrid 123	3	4	....	....	1	....	....	....	....	....	....	....	2	....	....	....	....	....	....	10
Total	40	39	35	25	7	7	6	4	4	4	4	3	2	2	2	2	1	1	1	189

Buffum No. 17.—This variety was originated from a plant found in a field of Turkey wheat by Prof. B. C. Buffum, of Worland, Wyo. After being increased, the wheat was distributed in 1912. It is now grown to a limited extent in Wyoming. It is one of the hardiest winter wheats grown in the Great Plains area, but has not yielded as well as other soft red winter varieties. It is beardless and has glabrous white glumes.

Seven samples of Buffum No. 17 have been milled and baked, the data on which are presented in Table 56. The average yield of straight flour from these samples was 71.1 per cent or only 0.4 per cent lower than for the Fulcaster samples, although the latter averaged 2.2 pounds higher in test weight per bushel of dockage-free wheat. This would indicate that Buffum No. 17 has a high flour yielding capacity. In baking qualities it is about equal to Fulcaster in water absorption and loaf volume, but is inferior in color and texture of loaf. It averaged the highest of all the varieties of its class in crude protein content. Considering all factors, this variety is a wheat of good milling and baking value.

Currell.—The Currell variety was originated from three heads found in a field of Fultz in Virginia by M. E. Currell in 1881. It is an awnless, glabrous, brown-glumed variety. It was first sold for seed in 1884. It is now most important in Missouri, Kansas, Maryland, Pennsylvania, New Jersey, and Virginia.

Six samples of the Currell variety have been milled and baked, the results are presented in Table 56.

The outstanding points regarding this variety are its high yield of straight flour and its low protein content, water absorption of flour, and weight and color of loaf. Compared with the Fulcaster variety, Currell is superior in flour yield but inferior in protein content and in baking quality. In general, it is a wheat of good milling and baking quality.

Fulcaster.—The Fulcaster variety is reported to have originated in 1886, from a cross between Fultz and Lancaster (Mediterranean)

made by M. S. Schindel, at Hagerstown, Md. The variety is known under many names, principal of which are Dietz Longberry, Stoner, and Miracle. It is a bearded, glabrous, white-glumed variety with purple stems, and is distinguished by the orange-colored stripes on the chaff. Fulcaster is widely adapted and is grown in largest quantities in Virginia, Pennsylvania, Oklahoma, Tennessee, Missouri, North Carolina, and Maryland. It is estimated that about 2,576,000 acres of Fulcaster were grown in the United States in 1919. It is second in importance among the soft red winter wheats and ranks fourth among all varieties of wheat grown in the United States.

Fulcaster appears to be the highest-yielding variety of wheat in most parts of eastern Kansas, Missouri, southern Illinois, Tennessee, West Virginia, and Maryland, and is one of the most productive varieties in several other Southern and Eastern States.

Twenty-three samples of the Fulcaster variety, or one of its synonyms, have been milled and baked, and the results are shown in Table 56. These data show for this variety a high average protein content, water absorption of flour, and volume, weight, texture, and color of loaf. Considering all factors, it is one of the very best milling and baking wheats in the soft red winter class.

Fultz.—The Fultz variety was developed in Mifflin County, Pa., in 1862 by Abraham Fultz. The wheat was increased for several years and later distributed widely over the United States. It has awnless, tapering spikes, glabrous white glumes, and purple stems. It is now the third and most important variety of wheat in the United States and the leading variety of soft red winter wheat. About 4,800,000 acres of Fultz wheat were grown in the United States in 1919. The States leading in the production of this wheat are Missouri, Illinois, Indiana, Kansas, and Ohio. Fultz is adapted to a large area. It is one of the leading varieties in practically all States south of the Ohio River and in portions of several States north of the Ohio. Fultz frequently is grown because it is beardless, although it may be less productive than Fulcaster or other bearded varieties.

Ten samples of the Fultz variety have been milled and baked. The results are shown in Table 56. This variety averages higher in flour yield than Fulcaster but lower in baking qualities. Fultz, although slightly inferior to Fulcaster, has proved to be a good milling and baking wheat.

Huston.—The Huston variety has been grown in Oregon since 1876, the original sample having been obtained from the Centennial Exposition, Philadelphia, Pa. It was introduced into the vicinity of Eugene, Oreg., and it is still grown in seven counties of western Oregon. It is estimated that 22,400 acres of the variety were grown in 1919. Huston is an awnless, glabrous, white-glumed spring wheat, but is grown from both fall and spring sowing in the Willamette Valley. Because of this and because it is a rather soft wheat, it is usually graded as soft red winter, although it also has been graded as a hard red spring wheat. Huston is among the highest yielding varieties for spring sowing in the Willamette Valley.

Six samples of the Huston wheat have been milled and baked. The results are shown in Table 56. The data show a high average test weight per bushel, a low average protein content, volume and texture of loaf, and a very high average ash content of flour. It has inferior milling and baking qualities.

Jones Fife.—The Jones Fife variety was originated by A. N. Jones, of Newark, N. Y., from crosses made about 1889, between Fultz, Mediterranean, and a wheat known as Russian Velvet. It has a beardless spike with pubescent, white glumes. Jones Fife is grown now in both the eastern and western parts of the United States, under humid, irrigated, and semi-arid conditions. It is most important in Washington, Illinois, Missouri, Indiana, and Ohio. About 476,000 acres of Jones Fife wheat were grown in 1919. This variety has not proved unusually productive, and is outyielded by other varieties in nearly all sections where it is grown.

Twenty-six samples of Jones Fife, or its several synonyms, have been milled and baked. The results are shown in Table 56. Compared with other varieties of the same class, it averages lowest in volume and texture of loaf. It is also low in all the other factors, indicating a very inferior quality of wheat. It is about the poorest in milling and baking quality of any of the soft red winter wheats.

Kinney.—The Kinney variety was introduced from France during the late sixties or early seventies into the Willamette Valley of Oregon. It is a beardless white-glumed variety of spring wheat, but is often grown from fall sowing. Because of this and because of its soft kernels, it is usually graded as soft red winter wheat, and is included in that class here, although it sometimes is graded as hard red spring wheat. It is outyielded by other varieties, such as White Winter, Huston, and Bluechaff, in the section where it is grown.

Six samples of the Kinney wheat have been milled and baked and the average results are shown in Table 56. It is shown to average high in test weight per bushel, yield of flour, and texture of loaf. It has the lowest protein content of all the varieties of its class. In general, it has inferior baking qualities, in that respect being about equal to Huston.

Mediterranean.—Mediterranean is one of the oldest varieties grown in the United States, having been introduced in 1819 from Genoa, Italy. During the next 30 or 40 years it rapidly became popular and spread into the western wheat-growing sections. It is now of most importance in Texas, Missouri, Oklahoma, Illinois, and Pennsylvania. In 1919 about 2,560,000 acres of the variety were grown. It is the third most important variety of soft red winter wheat. It is bearded, has glabrous, brown glumes and the kernels are rather large and soft. Mediterranean is the highest yielding variety in the humid sections of Texas and Oklahoma. It also yields well in southeastern Kansas and in Delaware and Pennsylvania.

Five samples of Mediterranean wheat have been milled and baked and the results are shown in Table 56. In flour yield and in weight and color of loaf, this variety averages higher than Fulcaster, but is lower in protein content, water absorption of flour, and volume and texture of loaf. In general, it is a wheat of good milling and baking quality.

Minhardi.—The Minhardi variety was developed at the Minnesota Agricultural Experiment Station from a cross between Odessa and Turkey made in 1902. Seed of the variety was first distributed to farmers in Minnesota in 1919. It is a beardless, white-glumed variety and is perhaps the hardiest winter wheat grown in the United States.

Because of its hardiness it has produced fair yields in parts of Minnesota.

Seven samples of the Minhardi variety have been milled and baked and the results are shown in Table 56. This variety averages second highest of its class in protein content. It is low in flour yield and ash content of flour, but the latter is an advantage. In loaf volume it is high, but is only medium in the other baking-quality factors. Considering all factors it may be said to be a wheat of medium milling and baking value.

Odessa.—The Odessa variety is probably of Russian origin, but it has been grown in the United States for at least 60 years. It is not an important variety in any State, but is grown to a considerable extent in Idaho and Utah. About 54,000 acres of the variety were grown in the United States in 1919. Odessa is an awnless variety with brown, glabrous glumes, and has rather small, slender, and rounded kernels. Although a hardy variety, it has not produced promising yields even in the Northern States.

Six samples of the Odessa wheat have been milled and baked and the average results are presented in Table 56. The data show for this variety a high flour yield and volume of loaf, and a low ash content of flour, in these respects being superior to Fulcaster. In the other quality factors, however, it is inferior to Fulcaster. In general, Odessa is a wheat of good milling and baking quality.

Purplestraw.—Purplestraw, known also as Alabama Bluestem and Georgia Red, is a very old variety grown in the southeastern United States. It is the leading variety of wheat in Georgia, Alabama, and South Carolina. About 273,000 acres of the variety were grown in the United States in 1919. It is a beardless, glabrous, white-glumed variety, and is really a spring wheat, but has been grown for many years only from fall sowing in the mild humid sections of the southeastern United States. It is graded, therefore, as a soft red winter wheat. Purplestraw is the highest yielding variety in most of the Southeastern States.

Six samples of the Purplestraw variety have been milled and baked, and the average results are given in Table 56. These results show a high yield of flour, volume, texture, and color of loaf, excelling Fulcaster in all except the last factor. In protein content and water absorption of flour it is about equal to the average of the class. Considering all factors, Purplestraw is a wheat of excellent milling and baking quality.

Red Rock.—Red Rock was developed at the Michigan Agricultural Experiment Station, from which it was first distributed for commercial growing in 1914. It has since become an important variety in Michigan, and is grown also in neighboring States. It is bearded and has glabrous, brown glumes. It closely resembles the Mediterranean variety, but the kernels are slightly larger and harder than that variety, and it is of much better milling quality. Red Rock is the highest yielding variety of winter wheat in the southern half of Michigan and adjacent sections of Indiana.

Thirty samples of Red Rock have been milled and baked. The results from these samples are shown in Table 56. This variety is highest of all the varieties of its class in water absorption of flour and in volume, texture, and color of loaf, and for that reason can be considered the variety of best baking quality of the soft red

winter wheats. In protein content and flour yield it is inferior to Fulcaster.

Red Russian.—The Red Russian variety is undoubtedly of European origin, as in appearance and time of maturity it greatly resembles the Squarehead wheat of northern Europe. It has been grown in Washington for thirty or forty years, and it is still an important wheat in the Palouse sections of Washington and Idaho. About 155,000 acres of Red Russian wheat were grown in 1919. Red Russian has large beardless, clavate spikes, glabrous white glumes, and large soft kernels. Because of its poor quality, it is graded in the official grain standards as Western Red. It is a productive variety only in the humid sections of western Washington and Oregon.

Thirty samples of the Red Russian variety have been milled and baked. The results are shown in Table 56. These results show a very low protein content, water absorption of flour, and volume, weight, and texture of loaf. The only good points apparent are its high flour yield and low ash content of flour. Red Russian, like Jones Fife, is a very inferior wheat from the standpoint of baking quality.

Triplet.—The Triplet variety was originated at the Washington Agricultural Experiment Station from crosses involving Jones Fife, Little Club, and Turkey. It was first distributed for commercial growing in 1919, and has since become rather widely grown in Washington and Oregon. Triplet is beardless and has pubescent, white glumes. It closely resembles the Jones Fife variety, but its kernels are harder and of better milling and baking quality. Because of its higher yields and quality, Triplet should replace Jones Fife in the sections of Oregon and Washington where the latter is grown.

Eleven samples of Triplet obtained principally from experiment stations in Washington and Oregon during the three years 1919 to 1921, have been milled and baked. The results are presented in Table 56. A high average is shown for this variety in protein content, water absorption of flour, and weight of loaf; in the last factor, it is highest in its class. It averages lowest in its class in yield of flour. In general Triplet is a variety of medium milling and baking quality.

Hybrid 123.—Hybrid 123 is a variety of club wheat and is graded under the official grain standards in the soft red winter wheat class. It was originated at the Washington Agriculture Experiment Station, Pullman, Wash., from a cross between Jones Fife and Little Club. Seed of the variety was distributed by the Washington station in 1907. It is a beardless, glabrous, white-glumed variety of spring wheat, but it is commonly grown from fall sowing in Washington. This variety should be replaced by Hybrid 128, a white-kerneled winter club wheat which is more productive.

Ten samples of Hybrid 123 obtained from experiment stations in Oregon and Washington during the three years 1919 to 1921, have been milled and baked. The results of these tests are shown in Table 56. This variety shows a low average yield of flour. In the other quality factors, it averages about midway between high and low for its class. In general, Hybrid 123 is a wheat of slightly below medium milling and baking value.

SUMMARY OF MILLING AND BAKING DATA FROM THE VARIETIES OF SOFT RED WINTER WHEAT.

The results obtained with the soft red winter wheats, as shown in Table 56 and in the discussions of the varieties, indicate that Red Rock has the highest bread-making qualities of the wheats of this class. Other good varieties are Purplestraw, Minhardi, Odessa, Fulcaster, Fultz, and Buffum No. 17. The poorest varieties in quality are Red Russian, Jones Fife, and Hybrid 123, while the other varieties not mentioned are of medium quality.

THE WHITE WHEATS.[11]

The commercial class of wheat known as White includes the common white wheats and the white clubs. Varieties of common white wheat are grown both in the eastern and western part of the United States. It is the leading class of wheat in Washington, California,

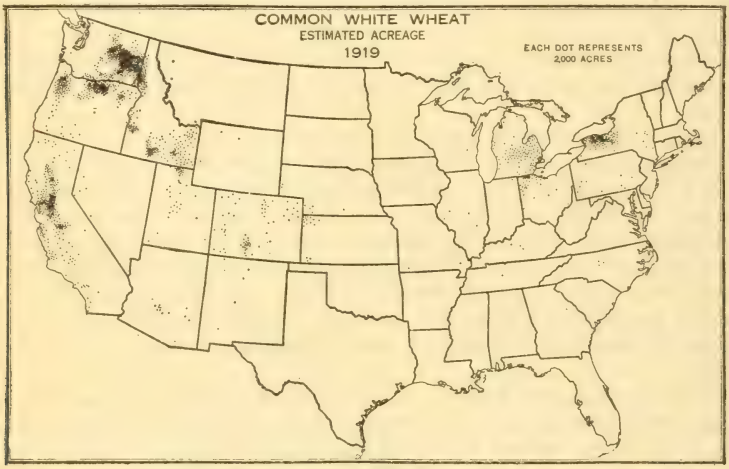


FIG. 9.—Distribution of common wheat of the White class.

Oregon, and Idaho, and is important in New York and Michigan. In these States it usually outyields the other classes of wheat. Over 3,000,000 acres of common white wheat are grown annually in the United States. It comprises somewhat more than 5 per cent of the total wheat acreage. The acreage of common white wheat in 1919 is shown in Figure 9 and in Table 58. More than 50 varieties of common white wheat are grown.

TABLE 58.—*Estimated acreage of common white wheat, 1919.*

State.	Acres.	State.	Acres.
Washington	1,179,100	Utah	87,200
California	656,400	Ohio	82,500
Oregon	492,400	Kansas	31,600
Idaho	458,100	Other States	114,700
New York	277,300		
Michigan	189,300	United States	3,703,400
Colorado	134,800		

[11] For more complete information concerning the varieties and adaptation of the white wheats, see Clark, J. Allen, Martin, John H., and Leighty, Clyde E.: The Common White Wheats. U. S. Department Agr. Farmers' Bul. 1301, and Clark, J. Allen, and Martin, John H.: The Club Wheats, U. S. Dept. Agr. Farmers' Bul. 1303.

White club wheat is grown only in the western part of the United States, principally in the three Pacific Coast States, Washington, Oregon, and California. More than 1,000,000 acres of white club wheat are grown annually in the United States, comprising slightly less than 2 per cent of the total wheat acreage. A map showing the distribution of the white club wheats is shown in Figure 10, and the acreage is shown in Table 59. Ten varieties of white club wheats are commercially grown.

TABLE 59.—*Estimated acreage of white club wheat, 1919.*

State	Acres.	State.	Acres.
Washington	471,600	New Mexico	20,100
California	330,100	Other States	34,300
Oregon	268,600		
Idaho	139,900	United States	1,298,100
Utah	33,500		

Milling and baking experiments have been conducted with many of the common white and white club varieties, but five tests or more have been made of only 13 of the common wheats and five of the white club varieties. The average data obtained from these varieties are shown in Table 60. The States from which the samples were obtained are listed in Table 61. Most of the samples of these varieties were obtained from experiment stations in the intermountain and Pacific coast sections of the western United States, in the area where this type of wheat is most commonly grown.

FIG. 10.—Distribution of club wheats of the white class.

The principal variety of this class of wheat is Pacific Bluestem, a common white wheat. It is a true spring wheat but is grown from fall sowing in the mild climate of California, Arizona, and western Oregon. In other sections it usually is grown from spring sowing. It was estimated that more than 1,550,000 acres of it were grown in 1919. Because of its importance, it has been grown as a standard for comparison of other white wheat varieties at the experiment stations and is used here as a basis of comparing the varieties as to quality. The data from all comparable samples of other varieties of this class and those of Pacific Bluestem are shown in Tables 62 to 72 to supplement the data in Table 60. As with previous classes, the varieties are discussed separately and in alphabetical order, except that the common and the club wheats are separated. Illustrations showing the relative differences in the quality of bread made from some of the principal varieties of the class are found in Plate V.

TABLE 60.—*Summary of milling and baking data on the varieties of white wheat grown during the seven years from 1915 to 1921, inclusive.*

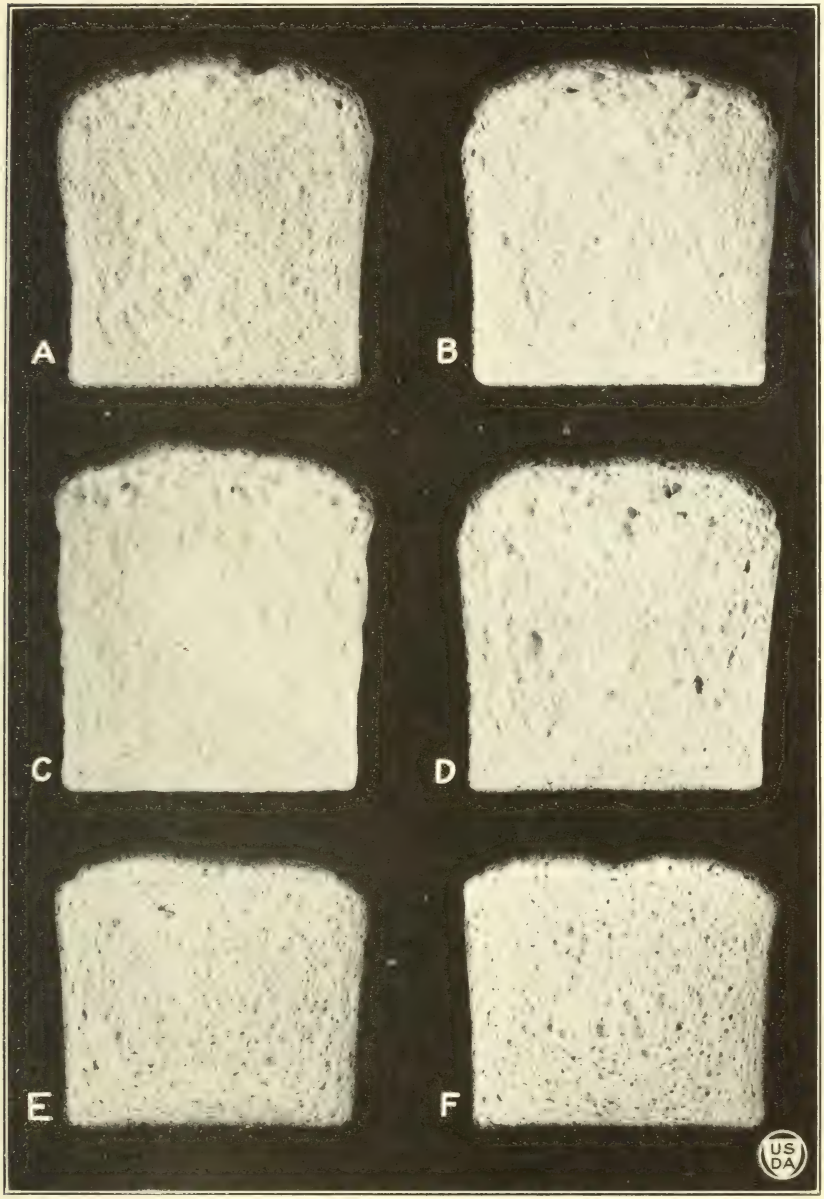
Variety.	Number of samples.[1]	Test weight per bushel.		Crude protein of wheat.	Milling yields.			Baking results.					Ash in flour.
		Dockage-free.	Mill-cleaned.		Straight flour.	Shorts.	Bran.	Water absorption of flour.	Loaf.				
									Volume.	Weight.	Texture.	Color.	
Common wheats:		*Lbs.*	*Lbs.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*C. c.*	*Gms.*	*Score.*	*Score.*	*P. ct.*
Baart	77	59.2	60.5	13.3	68.9	15.5	15.6	57.7	2,003	487	89.8	92.0	0.46
Bobs	10	58.1	58.9	13.0	73.4	13.7	12.9	59.8	2,264	498	92.2	92.7	.44
Bunyip	5	60.8	60.6	11.4	71.1	12.7	16.2	59.1	2,176	499	91.1	94.3	.46
Defiance	9	60.9	62.3	10.0	73.0	15.4	11.6	57.0	1,856	475	89.3	92.3	.49
Dicklow	30	56.1	57.6	12.9	70.1	13.7	16.2	56.5	1,947	487	88.7	91.5	.48
Federation	26	57.7	58.0	11.8	70.9	12.9	16.2	56.7	2,112	488	88.9	89.2	.46
Galgalos	25	58.3	59.9	15.3	69.9	15.0	15.1	61.2	2,080	503	89.1	91.6	.49
Goldcoin	52	59.2	60.8	10.4	72.3	14.5	13.2	53.9	1,536	463	78.9	88.7	.46
Hard Federation	34	59.1	59.7	13.3	70.5	15.5	14.0	63.1	2,139	507	89.9	93.4	.48
Pacific Bluestem	106	57.6	60.3	12.3	69.8	16.0	14.2	56.1	1,762	477	85.9	88.7	.49
Sonora	9	63.2	64.7	9.1	69.4	15.7	14.9	57.4	1,769	482	87.2	88.7	.43
Talimka	14	56.7	58.5	13.8	71.6	14.2	14.2	60.7	2,045	500	90.0	90.7	.46
White Federation	20	59.6	59.7	11.9	72.9	14.2	12.9	62.4	2,097	507	90.2	93.2	.49
Club wheats:													
Hybrid 63	5	59.7	64.0	10.1	74.2	15.8	10.0	57.2	1,770	482	87.9	91.6	.....
Hybrid 128	26	57.7	59.6	11.5	70.7	13.5	15.8	54.5	1,637	481	82.8	86.1	.47
Hybrid 143	11	61.8	63.2	9.6	70.5	15.4	14.1	54.9	1,846	479	89.0	89.6	.53
Jenkin	14	59.7	62.4	9.5	74.3	14.1	11.6	51.9	1,564	456	83.4	85.8	.48
Little Club	32	56.3	58.4	13.2	70.2	13.3	16.5	56.7	1,875	488	86.8	86.8	.48
Redchaff	6	59.1	63.4	9.5	72.7	16.6	10.7	52.3	1,598	454	83.1	89.8	.....
Average of varietal samples (Max. No. 511)		58.4	60.1	12.3	70.6	14.8	14.6	57.2	1,876	484	86.9	90.2	.47
Average of class[2] (Max. No. 580)		58.5	.....	12.0	70.7	14.8	14.5	56.8	1,872	484	87.2	90.2	.46

[1] This column contains the maximum number of samples used for each variety. In some instances particularly for the factors of loaf color and ash, the results given represent the average of a fewer number of samples for the reason that complete data on all the samples were not available. The number of samples used, for the various factors is given in Figures No. 12 to 23, inclusive.

[2] Average of all white wheat samples on which tests were made, including the varietal samples shown above.

TABLE 61.—*Number of samples of each variety of white wheat grown in each State, the data on which are given in Table 60.*

Variety.	Washington.	Oregon.	Idaho.	California.	Utah.	Montana.	North Dakota.	Wyoming.	Colorado.	Kansas.	New York.	Oklahoma.	Virginia.	Origin unknown.	Total.
Common wheats:															
Baart	36	12	7	6	6	4	....	....	1	3	....	1	1	....	77
Bobs	1	8	....	1	....	....	....	....	....	....	....	....	....	....	10
Bunyip	....	1	....	4	....	....	....	....	....	....	....	....	....	....	5
Defiance	....	4	3	....	....	....	1	....	1	....	....	....	....	....	9
Dicklow	5	7	9	3	5	....	1	....	....	....	....	....	....	....	30
Federation	5	8	5	4	2	2	....	....	....	....	....	....	....	....	26
Galgalos	2	8	2	3	3	4	....	2	1	....	....	....	....	....	25
Goldcoin	19	24	3	....	4	....	....	....	....	....	2	....	....	....	52
Hard Federation	3	9	5	7	2	4	2	2	....	....	....	....	....	....	34
Pacific Bluestem	50	25	16	9	6	....	....	....	....	....	....	....	....	....	106
Sonora	....	1	2	5	1	....	....	....	....	....	....	....	....	....	9
Talimka	3	4	2	1	4	....	....	....	....	....	....	....	....	....	14
White Federation	2	5	2	6	2	3	....	....	....	....	....	....	....	....	20
Club wheats:															
Hybrid 63	5	....	....	....	....	....	....	....	....	....	....	....	....	....	5
Hybrid 128	11	9	....	3	3	....	....	....	....	....	....	....	....	....	26
Hybrid 143	8	1	1	....	....	....	....	....	....	....	....	....	....	1	11
Jenkin	9	1	4	....	....	....	....	....	....	....	....	....	....	....	14
Little Club	8	13	3	4	4	....	....	....	....	....	....	....	....	....	32
Redchaff	2	4	....	....	....	....	....	....	....	....	....	....	....	....	6
Total	169	144	64	56	42	17	4	4	3	3	2	1	1	1	511



LOAVES OF BREAD FROM SIX VARIETIES OF WHITE WHEAT GROWN AT MORO, OREG. IN 1921.

The varieties, with the average loaf volumes, are as follows: *A*, Baart, 2,080 c. c.; *B*, Pacific Bluestem, 1,980 c. c.; *C*, Hard Federation, 2,090 c. c.; *D*, Federation, 1,930 c. c.; *E*, Goldcoin, 1,650 c. c.; *F*, Hybrid 128, 1,670 c. c.

Baart.—The Baart (Early Baart) wheat, also known as Arizona Baart, Columbia, and Diener No. 18, was introduced into the United States from Australia by the United States Department of Agriculture in 1900. It is now grown in all of the States west of the Great Plains area, except possibly in Wyoming. About 500,000 acres of Baart wheat were grown in 1919. It is most important in Washington and California. It is an awned, glabrous, white-glumed variety with large semihard white kernels.

Baart is one of the highest yielding varieties in California and Arizona, and is a high yielding spring variety for the dry lands of Oregon and Washington.

Seventy-seven samples of the Baart variety have been milled and baked as shown in Table 60. Many of these samples are from commercial sources, grown in the States of Oregon, Washington, and California. Thirty-four of the samples were obtained from the experiment stations of the Pacific Coast States and represent the five crop years 1917 to 1921, inclusive. These samples can be directly compared with an equal number of samples of Pacific Bluestem grown under the same conditions. The comparable data are shown in Table 62. The data show Baart wheat to have a heavier test weight per bushel than Pacific Bluestem and to exceed slightly that variety in crude protein content, in yield of flour, and in water absorption. It considerably exceeds the Pacific Bluestem in volume and color of loaf, and is slightly superior in weight and texture of loaf. It has averaged slightly lower than Pacific Bluestem in ash in the flour. The results clearly show that the Baart wheat is considerably superior to Pacific Bluestem in all important milling and bread-making factors.

TABLE 62.—*Summary of milling and baking data on 34 samples of Baart and 34 comparable samples of Pacific Bluestem grown during the five years from 1917 to 1921, inclusive.*

Descriptive data.	Baart.	Pacific Bluestem.	Percentage of Pacific Bluestem.
Number of samples	34	34	
Test weight per bushel (mill-cleaned wheat)....pounds..	59.8	58.2	102.7
Crude protein content of wheat....per cent..	13.6	13.4	101.5
Yield of straight flour....do....	69.4	69.1	100.4
Yield of shorts....do....	14.6	13.8	105.8
Yield of bran....do....	16.0	17.1	93.6
Water absorption of flour....do....	57.0	56.6	100.7
Volume of loaf....cubic centimeters..	2,017	1,850	109.0
Weight of loaf....grams..	490	489	100.2
Texture of loaf....score..	89.2	87.0	102.5
Color of loaf....do....	92.0	87.8	104.8
Ash in flour[1]....per cent..	0.48	0.50	96.0

[1] Average of 28 samples.

Bobs.—The Bobs variety was originated by William Farrer, of New South Wales, Australia, in 1896. It is a beardless spring wheat, with glabrous, white glumes and hard, white kernels. Although it has been introduced into the United States several times, it has never become an important wheat and is now grown commercially only in two coast counties of California. In recent years it has been under experiment at several experiment stations in the Pacific coast area but has not yielded as well as several other varieties.

Ten samples of the variety have been milled and baked, nine of which are directly comparable with samples of Pacific Bluestem. The data are presented in Tables 60 and 63. The samples were obtained from experiment stations in Oregon, California, and Washington during the five years from 1917 to 1921, inclusive. The data show the Bobs variety to exceed considerably the Pacific Bluestem in all milling and bread-making factors except percentage of crude protein, and in ash in the flour, which is slightly higher. The Bobs variety exceeds all other white wheats in loaf volume and is nearly equal to the best varieties of hard red spring wheats for milling and bread making. Bobs has not been increased and distributed from experiment stations for commercial growing because of its comparative low acre yield, even though the milling and baking experiments have shown it to be the best of the white wheats for milling and bread-making purposes.

TABLE 63.—*Summary of milling and baking data on nine samples of Bobs and nine comparable samples of Pacific Bluestem grown during the five years from 1917 to 1921, inclusive.*

Descriptive data.	Bobs.	Pacific Bluestem.	Percentage of Pacific Bluestem.
Number of samples	9	9	.....
Test weight per bushel (mill-cleaned wheat).....pounds..	59.2	57.1	103.7
Crude protein content of wheat.....per cent..	12.8	13.5	94.8
Yield of straight flour.....do....	73.9	68.5	107.9
Yield of shorts.....do....	13.8	13.7	100.7
Yield of bran.....do....	12.3	17.8	69.1
Water absorption of flour.....do....	60.0	56.8	105.6
Volume of loaf.....cubic centimeters..	2,266	1,844	122.9
Weight of loaf.....grams..	498	490	101.6
Texture of loaf.....score..	92.5	86.1	107.4
Color of loaf.....do....	93.1	85.9	108.4
Ash in flour[1].....per cent..	0.51	0.50	102.0

[1] Average of 8 samples.

Bunyip.—The Bunyip variety originated through hybridization by William Farrer, of New South Wales, Australia, about 1897. Several introductions of the variety have been made into the United States. In 1915 a sample was on exhibit at the Panama-Pacific exposition at San Francisco, Calif. From this source the Sperry Flour Co. obtained a sample, and after testing it in comparison with other Australian varieties, it was distributed by them for commercial growing in California in 1918. It is now grown to a considerable extent in the San Joaquin and Sacramento Valleys of California. It is an early beardless spring wheat, with glabrous, white glumes, and soft to semihard kernels. In California it is usually grown from fall sowing. Bunyip is one of the best varieties for the Sacramento and San Joaquin Valleys of California.

Five samples of the Bunyip wheat have been milled and baked. Two of these are commercial samples and the others were obtained from experiment stations in Oregon and California during the two years 1920 and 1921. The data for all tests are shown in Table 60. The results show the Bunyip variety to rank high among the common white wheats in both milling and bread-making factors. Although it averages rather low in crude protein content, it has a good water absorption of flour and produces a large loaf.

Defiance.—The Defiance variety was developed by Cyrus G. Pringle, of Charlotte, Vt., in 1871. It was first distributed in 1878. It apparently was not entirely purified before being distributed, but several selections have been made from the variety which have become commercially established. It is a spring wheat well adapted for growing under irrigation. It is awnless, with glabrous, white glumes, and semihard to hard kernels. Nearly 200,000 acres of Defiance, including selections from it, were grown in the United States in 1919. It is most important in Colorado, California, Oregon, and Idaho. It is best adapted to the coastal valleys of California and to irrigated land in Colorado.

Nine samples of Defiance wheat have been milled and baked and the average data are shown in Table 60. Most of these samples are from commercial sources. The data show it to have a heavy test weight per bushel and a high yield of flour, but to average rather low in crude protein, water absorption, and loaf volume. In general, it is only slightly better than the average for the class.

Dicklow.—The Dicklow wheat was selected from a field of Surprise or California Club in Utah Co., Utah, by Richard Low. It was distributed in southern Idaho in 1912 and 1913, where it is now the most important spring wheat grown under irrigation. More than 160,000 acres of Dicklow wheat were grown in 1919. It is a late-maturing spring wheat, with beardless heads which are quite clubbed at the tip. The kernels are somewhat flattened and soft. Those coming from the upper part of the spike much resemble club wheat. Dicklow is a high-yielding wheat on irrigated land in southern Idaho and northern Utah, exceeded only by Federation.

Thirty samples of the Dicklow variety have been milled and baked. Twenty-four of these samples can be directly compared with samples of Pacific Bluestem grown at experiment stations under the same conditions. This comparison is shown in Table 64. These samples were grown both on dry land and under irrigation, and represent the five crop years 1917 to 1921, inclusive. The data show the Dicklow variety to equal the Pacific Bluestem in the important milling factors and to exceed it significantly in loaf volume. Although a soft-kerneled wheat, the Dicklow variety is fairly well adapted for milling and bread making, ranking well with the other common white wheats.

TABLE 64.—*Summary of milling and baking data on 24 samples of Dicklow and 24 comparable samples of Pacific Bluestem grown during the five years from 1917 to 1921, inclusive.*

Descriptive data.	Dicklow.	Pacific Bluestem.	Percentage of Pacific Bluestem.
Number of samples	24	24	
Test weight per bushel (mill-cleaned wheat).....pounds..	56.7	58.9	96.3
Crude protein content of wheat.....per cent..	13.3	13.3	100.0
Yield of straight flour.....do....	69.8	69.6	100.3
Yield of shorts.....do....	13.4	14.5	92.4
Yield of bran.....do....	16.8	15.9	105.7
Water absorption of flour.....do....	56.4	56.3	100.2
Volume of loaf.....cubic centimeters..	1,943	1,824	106.5
Weight of loaf.....grams..	488	492	99.2
Texture of loaf.....score..	88.1	87.0	101 3
Color of loaf[1].....do....	91.1	89.0	102.4
Ash in flour[2].....per cent..	0.50	0.50	100.0

[1] Average of 22 samples. [2] Average of 18 samples.

Federation.—Federation originated from a cross between Purplestraw and Yandilla made by William Farrer, of New South Wales, Australia. Seed of the variety was introduced into the United States in 1914 by the United States Department of Agriculture. After being tested in the Pacific Coast States for several years it was first distributed to farmers in Oregon in 1920. About 1,000 acres of the variety were grown in Oregon and Idaho in 1922. It has proved to be a high-yielding wheat under irrigation, and its acreage may be expected to increase rapidly. It is beardless and has brown, glabrous glumes and rather soft kernels.

Twenty-six samples of Federation wheat have been milled and baked, 19 of which can be directly compared with Pacific Bluestem. The data are shown in Tables 60 and 65. The comparable data presented in Table 65 show the Federation variety to average considerably lower than Pacific Bluestem in crude protein, but to exceed it in yield of straight flour. It is practically equal to Pacific Bluestem in water absorption of flour, but considerably exceeds that variety in loaf volume, and to a less degree exceeds it in weight, texture, and color of loaf. It also has averaged considerably less in ash content of flour. In general, the Federation variety is one of the best of the soft white wheats for milling and bread-making purposes. In baking qualities it exceeds the Dicklow variety with which it comes into competition on the irrigated lands.

TABLE 65.—*Summary of milling and baking data on 19 samples of Federation and 19 comparable samples of Pacific Bluestem grown during the four years from 1918 to 1921, inclusive.*

Descriptive data.	Federation.	Pacific Bluestem.	Percentage of Pacific Bluestem.
Number of samples	19	19	
Test weight per bushel (mill-cleaned wheat)....pounds	57.1	57.8	99.7
Crude protein content of wheat....per cent	12.9	13.2	91.7
Yield of straight flour....do	70.5	68.2	103.4
Yield of shorts....do	13.2	13.4	98.5
Yield of bran....do	16.3	18.4	88.6
Water absorption of flour....do	56.8	56.9	99.8
Volume of loaf....cubic centimeters	2,130	1,838	115.9
Weight of loaf....grams	499	491	101.6
Texture of loaf....score	89.3	85.9	104.0
Color of loaf[1]....do	89.7	88.4	101.5
Ash in flour....per cent	0.46	0.50	92.0

[1] Average of 17 samples.

Galgalos.—Galgalos was introduced from Russia by the United States Department of Agriculture in 1903. It was distributed later in California and small quantities were sent to other States. The wheat is now grown in Oregon and California. Nearly 35,000 acres of the variety were grown in 1919. Galgalos is a spring wheat but is commonly grown from fall sowing. It is beardless and has pubescent, brown glumes. The kernels are rather long, slender, and soft. Although a productive variety in some sections, Galgalos has not become important largely on account of its weak straw, and it is not being recommended.

In all, 25 samples of Galgalos wheat have been milled and baked. Sixteen of these can be directly compared with samples of Pacific

Bluestem. The results are presented in Tables 60 and 66. The data show Galgalos to compare very favorably with the other white wheats. It considerably exceeds the Pacific Bluestem in crude protein content and slightly exceeds it in test weight per bushel and yield of flour. It is outstandingly higher in water absorption, volume, weight, texture, and color of loaf. In all respects the Galgalos variety is a good milling and bread-making wheat.

TABLE 66.—*Summary of milling and baking data on 16 samples of Galgalos and 16 comparable samples of Pacific Bluestem grown during the five years from 1917 to 1921, inclusive.*

Descriptive data.	Galgalos.	Pacific Bluestem.	Percentage of Pacific Bluestem.
Number of samples	16	16	
Test weight per bushel (mill-cleaned wheat)....pounds..	59.4	58.2	102.1
Crude protein content of wheat....per cent..	14.6	13.6	107.4
Yield of straight flour [1]....do....	70.5	69.7	101.1
Yield of shorts [1]....do....	14.6	14.3	102.1
Yield of bran [1]....do....	14.9	16.0	93.1
Water absorption of flour....do....	61.2	56.4	108.5
Volume of loaf....cubic centimeters..	2,093	1,809	115.7
Weight of loaf....grams..	505	485	104.1
Texture of loaf....score..	90.8	86.7	104.7
Color of loaf [1]....do....	92.7	90.0	103.0
Ash in flour [2]....per cent..	0.52	0.51	102.0

[1] Average of 15 samples. [2] Average of 10 samples.

Goldcoin.—The Goldcoin variety, known also as Fortyfold, No. 6, and by many other names, is one of the oldest varieties of white wheat grown in the United States. It apparently has been grown under one name or another since 1840, but under the names Goldcoin and Fortyfold only since about 1890. It is a winter wheat and is grown both in the eastern and western United States. In the West it is almost always called Fortyfold. In New York it is often called No. 6. The heads are beardless and distinctly clubbed at the tip. The glumes are glabrous and brown, and the kernels are very soft. In 1919 nearly 1,000,000 acres of Goldcoin, under one or another of the several names, were grown in the United States, and it is second in importance among the common white wheats. It is most important in Washington, New York, Oregon, Michigan, and Idaho. Goldcoin appears to be well adapted to the section around Spokane, Wash., and to parts of the upper Columbia Basin section of Oregon, but in other sections is outyielded by other varieties of better quality.

Fifty-two samples of Goldcoin have been milled and baked, the most of which were obtained from commercial sources in the western United States. Twelve of these samples were obtained from experiment stations in Washington, Oregon, and Utah during the four years 1918 to 1921, inclusive, and can be directly compared with samples of the Pacific Bluestem variety grown under the same conditions except that the Bluestem was sometimes grown from spring sowing. The results from these comparable samples are shown in Table 67. The data show the Goldcoin variety to exceed Pacific Bluestem in test weight per bushel, but to average consider-

ably less in crude protein content. In water absorption of flour, and in volume, weight, and texture of loaf, it is considerably inferior to Pacific Bluestem, but it exceeds that variety in yield of flour and color of loaf and has a lower ash in the flour. The Goldcoin variety has been found to be one of the poorest varieties of white wheat for milling and bread making.

TABLE 67.—*Summary of milling and baking data on 12 samples of Goldcoin and 12 comparable samples of Pacific Bluestem grown during the four years from 1918 to 1921, inclusive.*

Descriptive data.	Goldcoin.	Pacific Bluestem.	Percentage of Pacific Bluestem.
Number of samples	12	12	
Test weight per bushel (mill-cleaned wheat)...pounds..	58.3	56.8	102.6
Crude protein content of wheat...per cent..	12.3	14.4	85.4
Yield of straight flour...do....	70.9	66.9	106.0
Yield of shorts...do....	12.3	13.5	91.1
Yield of bran...do....	16.8	19.6	85.7
Water absorption of flour...do....	54.0	58.0	93.1
Volume of loaf...cubic centimeters..	1,675	1,943	86.2
Weight of loaf...grams..	476	493	96.6
Texture of loaf...score..	85.8	88.0	97.5
Color of loaf...do....	89.0	87.4	101.8
Ash in flour...per cent..	0.47	0.50	94.0

Hard Federation.—Hard Federation was selected from Federation about 1908 by J. T. Pridham, Cowra Experiment Station, in New South Wales, Australia. It was introduced into the United States by the United States Department of Agriculture in 1915, and was first distributed in 1920 to farmers in Oregon and California. Further distributions have been made since, and about 6,000 acres of the variety were grown in 1922. It is a spring wheat which has proved to be a high-yielding variety under dry-land conditions in Oregon. In California it is grown from fall sowing and is well adapted to some soils. It is beardless and has glabrous, brown glumes, while the kernels are short, broad, thick, hard, and translucent.

Thirty-four samples of the Hard Federation variety have been milled and baked, representing the four crop years 1918 to 1921, inclusive. Until 1920, almost all of the samples were obtained from the experiment stations in Oregon, California, Washington, and Idaho, but in 1921 several samples were obtained from experiment stations in the northern Great Plains area. Twenty-two samples can be directly compared with Pacific Bluestem. These comparable data are shown in Table 68.

The data show the Hard Federation variety to exceed Pacific Bluestem considerably in all milling and bread-making factors. It has a high yield of straight flour, water absorption of flour, and loaf volume, and in all other respects is a first-class wheat for milling and bread-making purposes. It is one of the best of the white wheats.

TABLE 68.—*Summary of milling and baking data on 22 samples of Hard Federation and 22 comparable samples of Pacific Bluestem grown during the four years from 1918 to 1921, inclusive.*

Descriptive data.	Hard Federation.	Pacific Bluestem.	Percentage of Pacific Bluestem.
Number of samples	22	22	
Test weight per bushel (mill-cleaned wheat)...pounds..	59.9	58.3	102.7
Crude protein of wheat...per cent..	12.8	12.7	100.8
Yield of straight flour...do....	71.1	68.5	103.8
Yield of shorts...do....	15.1	13.0	116.2
Yield of bran...do....	13.8	18.5	74.6
Water absorption of flour...do....	62.6	56.7	110.4
Volume of loaf...cubic centimeters..	2,109	1,848	114.1
Weight of loaf...grams..	507	491	103.3
Texture of loaf...score..	90.0	86.7	103.8
Color of loaf...do....	93.0	87.2	106.7
Ash in flour...per cent..	0.47	0.50	94.0

Pacific Bluestem.—As previously stated, Pacific Bluestem is the leading variety of white wheat. It is of Australian origin, but has been grown in the Pacific coast area of the United States for nearly 70 years. In California this wheat is generally known as White Australian, but in the Pacific Northwest it is usually called Bluestem. It is a true spring wheat, but is grown from fall sowing in California and Arizona, and occasionally in Oregon and Washington. It is beardless and has glabrous, white glumes, and soft to semihard kernels. It is most important in Washington, California, Idaho, and Oregon. More than 1,350,000 acres were grown in 1919. Pacific Bluestem formerly was one of the most productive varieties in the Pacific Coast States, but is now being replaced by Baart, and also by Bunyip in California and Hard Federation in Oregon.

One hundred and six samples of Pacific Bluestem have been milled and baked. The average results are presented in Table 60. As this variety has been used as a standard for comparing other white wheats, the results of comparable samples with other varieties are shown in Tables 62 to 73.

Pacific Bluestem was for many years considered the best milling and baking wheat grown in the Pacific Coast States. Since the introduction of hard red winter and hard red spring varieties into that section during the past 15 to 20 years, it has lost this leading position, although it still often sells at a premium over other wheats. Among the white wheats, it is now inferior to more recently introduced varieties, including Baart, Bobs, Bunyip, Federation, Hard Federation, and White Federation. The results show, however, that it represents about the average in quality of the white wheats which have been included in the milling and baking experiments reported in this bulletin.

Sonora.—The Sonora variety, known also as Ninety Day and Redchaff, was introduced into California from Mexico by the Spanish Fathers one hundred to one hundred and fifty years ago. It is the oldest variety known in California and Arizona, where it is still an important variety. It is beardless and has pubescent, brown glumes, and small, soft kernels. Because of its poor milling and baking qualities, it is graded with the club wheats in the subclass Western White. However, it is a common wheat. About 240,000 acres of Sonora were grown in the United States in 1919, nearly four-fifths of which were grown in California. It is one of the highest yielding

varieties for the irrigated lands in the upper San Joaquin Valley of California and in southern Arizona.

Nine samples of Sonora have been milled and baked: the results are shown in Table 60. It will be noted that the Sonora variety ranks lowest in crude protein and is very low in yield of flour, water absorption of flour, and volume of loaf. It is similar to the club wheats in milling and baking quality.

Talimka.—The Talimka variety is of Russian origin. It is grown in the United States only as a mixture with Chul, which is identical with Talimka, except in having red kernels. Talimka has not produced high comparative yields. It has been carefully tested at experiment stations but not distributed widely for commercial growing because it has several undesirable characters such as weak stems and it has only medium acre yields.

Fourteen samples of Talimka have been milled and baked. The results are shown in Tables 60 and 69. The results presented in the latter table show Talimka to be considerably superior to the Pacific Bluestem in milling and bread-making qualities. But it is such a hard wheat that it is difficult to mill and it would probably not meet with favor with the milling trade if commercially produced. The variety has now been discontinued in the experiments at most experiment stations in the areas where it has been tried.

TABLE 69.—*Summary of milling and baking data on 10 samples of Talimka and 10 comparable samples of Pacific Bluestem grown during the five years from 1917 to 1921, inclusive.*

Descriptive data.	Talimka.	Pacific Bluestem.	Percentage of Pacific Bluestem.
Number of samples	10	10	
Test weight per bushel (mill-cleaned wheat)...pounds	58.3	56.2	103.7
Crude protein content of wheat...per cent	14.3	14.5	98.6
Yield of straight flour...do	71.2	66.5	107.1
Yield of shorts...do	14.1	15.9	88.7
Yield of bran...do	14.7	17.6	83.5
Water absorption of flour...do	60.3	56.3	107.1
Volume of loaf...cubic centimeters	2,039	1,851	110.2
Weight of loaf...grams	499	486	102.7
Texture of loaf...score	90.5	86.7	104.4
Color of loaf[1]...do	91.8	89.4	102.7
Ash in flour...per cent	0.46	0.52	88.5

[1] Average of 9 samples.

White Federation.—White Federation was developed from a selection of Federation at the Cowra Experiment Station in Australia. It was introduced into the United States in 1916 by the United States Department of Agriculture. It was first distributed for commercial growing in the fall of 1919 in California from the United States Plant Introduction Station at Chico, Calif., where it had produced good yields. A few hundred acres were grown in that State in 1922. White Federation differs from Hard Federation principally in having white rather than brown glumes. It differs from Federation in having shorter and harder kernels. The kernels are not usually quite as hard or translucent as those of Hard Federation. It has not outyielded Hard Federation in most experiments.

Twenty samples of the White Federation wheat have been milled and baked from samples obtained from experiment stations in the Pacific coast area of the United States during the four years 1918

to 1921, inclusive. Sixteen of these samples can be directly compared with samples of Pacific Bluestem grown under the same conditions. This comparison is shown in Table 64. The results show White Federation to have a heavier test weight per bushel, but to average slightly less in crude protein than Pacific Bluestem. It has produced, however, a significantly higher yield of flour, as well as a greater water absorption of flour, and volume, weight, texture, and color of loaf. White Federation has proved to be one of the best white wheats for milling and bread making.

TABLE 70.—*Summary of milling and baking data on 16 samples of White Federation and 16 comparable samples of Pacific Bluestem grown during the four years from 1918 to 1921, inclusive.*

Descriptive data.	White Federation.	Pacific Bluestem.	Percentage of Pacific Bluestem.
Number of samples	16	16	
Test weight per bushel (mill-cleaned wheat).....pounds..	59.6	58.5	101.9
Crude protein content of wheat.....per cent..	11.6	12.1	95.9
Yield of straight flour.....do....	73.3	69.0	106.2
Yield of shorts.....do....	13.8	11.8	116.9
Yield of bran.....do....	12.9	19.2	67.2
Water absorption of flour.....do....	62.2	56.3	110.5
Volume of loaf.....cubic centimeters..	2,063	1,824	113.1
Weight of loaf.....grams..	507	490	103.5
Texture of loaf.....score..	90.2	86.8	103.9
Color of loaf [1].....do....	92.5	88.6	104.4
Ash in flour.....per cent..	0.51	0.50	102.0

[1] Average of 14 samples.

Hybrid 63.—Hybrid 63 was produced at the Washington Agricultural Experiment Station from a cross between Little Club and Turkey. The wheat was distributed to farmers in 1907. It differs from Hybrid 128 and Hybrid 143 principally in having longer and harder kernels. It is a spring wheat, although usually fall sown. It is estimated that about 40,000 acres of the variety were grown in 1919 in Washington and Oregon. It usually is outyielded by Hybrid 128 in those States.

Five samples of the Hybrid 63 variety have been milled and baked. These are principally from commercial sources in the localities where grown. The data as given in Table 60 show Hybrid 63 to have a heavy test weight per bushel and a high flour yield and water absorption of flour, but to have a comparatively low volume, texture, and color of loaf. It represents about the average of the white club wheats in milling and baking qualities.

Hybrid 128.—Hybrid 128 was originated at the Washington Agricultural Experiment Station from a cross between Jones Fife and Little Club. Seed of the variety has been distributed from the Washington station since about 1908. It is now the most important variety of club wheat grown in the United States. Hybrid 128 is a winter wheat and can not be successfully grown from spring sowing. It has beardless spikes and white, glabrous glumes, and soft kernels which are irregular in shape. The variety is very susceptible to bunt or stinking smut, but in spite of this it is a very high yielder. It is estimated that more than 240,000 acres of Hybrid 128 were grown in 1919. It is most important in Walla Walla and Whitman Counties, Wash., and in Umatilla County, Oreg. In this section it usually outyields all other varieties.

Twenty-six samples of Hybrid 128 have been milled and baked, the average results of which are presented in Table 60. Several of these samples are from commercial sources. Seventeen of them, however, came from experiment stations and can be compared with an equal number of Pacific Bluestem samples grown in the same year. The samples are comparable except that Pacific Bluestem was grown from spring sowing in some cases, while all samples of Hybrid 128 were grown from fall sowing. The samples are thought, however, to be sufficiently comparable to warrant a comparison and the results are shown in Table 71. The data show Hybrid 128 to be high in yield of flour, low in crude protein content of wheat and water absorption of flour, and to be low in texture and color of loaf and exceptionally low in loaf volume. It is one of the poorest of the white club wheats in milling and baking values. Much of this wheat grown in the Pacific coast area is exported, and therefore it is not much used for milling and bread-making purposes in this country.

TABLE 71.—*Summary of milling and baking data on 17 samples of Hybrid 128 and 17 comparable samples of Pacific Bluestem grown during the five years from 1917 to 1921, inclusive.*

Descriptive data.	Hybrid 128.	Pacific Bluestem.	Percentage of Pacific Bluestem.
Number of samples	17	17	
Test weight per bushel (mill-cleaned wheat)...pounds	58.5	57.3	102.1
Crude protein content of wheat...per cent	12.1	13.8	87.7
Yield of straight flour...do	70.1	67.4	104.0
Yield of shorts...do	12.3	13.3	92.5
Yield of bran...do	17.6	19.3	91.2
Water absorption of flour...do	55.1	57.1	96.5
Volume of loaf...cubic centimeters	1,680	1,909	88.0
Weight of loaf...grams	488	489	99.8
Texture of loaf...score	84.6	87.3	96.9
Color of loaf [1]...do	86.9	88.5	98.2
Ash in flour [2]...per cent	0.47	0.50	94.0

[1] Average of 13 samples. [2] Average of 16 samples.

Hybrid 143.—Hybrid 143 was originated at the Washington Agricultural Experiment Station from a cross between Little Club and White Track, the latter a common white winter wheat. This hybrid wheat was first distributed by the Washington station in 1907 and has since become rather widely grown in Washington. It is estimated that about 50,000 acres of the variety were grown in 1919. Hybrid 143 usually is grown from fall sowing, but if sown early can be successfully grown from spring seeding. The heads and kernels are very small and short, and the kernels are considerably harder than those of Hybrid 128. Hybrid 143 usually is outyielded by Hybrid 128 when fall sown and by several common and other club varieties when sown in the spring.

Eleven samples of Hybrid 143 have been milled and baked. Most of these samples are from commercial sources and therefore can not be compared with Pacific Bluestem. The data presented in Table 60 show Hybrid 143 to have a heavy test weight per bushel, but to average low in crude protein content, flour yield, and water absorption. It has, however, averaged higher than most of the varieties of White Club wheat in volume, texture, and color of loaf.

Jenkin.—Jenkin has been grown in eastern Washington at least since 1895, but its origin is not known. It is a tall, late variety of

spring wheat, with a beardless spike and glabrous, brown glumes. About 70,000 acres were estimated as grown in 1919. It is grown principally from fall sowing in the subhumid sections of southeastern Washington and northwestern Idaho where it is perhaps the highest yielding wheat.

In all, fourteen samples of the Jenkin variety have been milled and baked. The results are shown in Table 60. These samples were almost all received from commercial sources in the sections where the variety is commonly grown. The data show Jenkin to have a heavy test weight per bushel and flour yield, but to have a very low crude protein content, water absorption of flour, and volume, weight, texture, and color of loaf. In general, Jenkin, like all of the other club wheats tested, is not well adapted for bread making.

Little Club.—The Little Club variety was probably introduced from Chile, but was grown in California as early as 1878. It was formerly the leading variety of wheat in eastern Oregon and Washington. In recent years it has been largely replaced by more productive varieties, although it was estimated that more than 100,000 acres of Little Club were grown in 1919. It is beardless, with white, glabrous glumes and soft kernels. Little Club is a spring wheat, but most often is grown from fall sowing. It is best adapted to subhumid conditions but is outyielded by other varieties in nearly all sections.

Thirty-two samples of Little Club wheat from commercial sources and from experiment stations have been milled and baked. Twenty-eight of the samples are from the latter source and can be directly compared with samples of Pacific Bluestem, both having been grown under the same conditions. These comparable results are shown in Table 72. The results show the Little Club variety to average somewhat higher than Pacific Bluestem in crude protein content and in yield of flour, as well as in water absorption of flour, and in volume and weight of loaf. The differences in all factors, however, are not significant, and in these experiments, therefore, the two varieties appear to be practically equal in milling and bread-making value. Little Club is the best of the white club wheats in both milling and bread-making qualities.

TABLE 72.—*Summary of milling and baking data on 28 samples of Little Club and 28 comparable samples of Pacific Bluestem grown during the five years from 1917 to 1921, inclusive.*

Descriptive data.	Little Club.	Pacific Bluestem.	Percentage of Pacific Bluestem.
Number of samples	28	28	
Test weight per bushel (mill-cleaned wheat)....pounds..	57.8	57.9	99.8
Crude protein content of wheat....per cent..	13.6	13.4	101.5
Yield of straight flour....do....	69.9	68.6	101.9
Yield of shorts....do....	13.3	14.1	94.3
Yield of bran....do....	16.8	17.3	97.1
Water absorption of flour....do....	56.9	56.7	100.4
Volume of loaf....cubic centimeters..	1,873	1,863	100.5
Weight of loaf....grams..	490	489	100.2
Texture of loaf....score..	86.7	87.4	99.2
Color of loaf[1]....do....	86.7	88.5	98.0
Ash in flour[2]....per cent..	0.49	0.50	98.0

[1] Average of 23 samples.

[2] Average of 22 samples.

Redchaff.—Redchaff has been an important variety in portions of the Columbia Basin of Oregon and Washington for nearly 20 years. It differs from Jenkin in being shorter and earlier, and in having more club-shaped heads and lighter brown glumes. Although a spring wheat, Redchaff most often is fall sown. About 40,000 acres of the variety were reported grown in 1919. Redchaff is a high yielding wheat along the foothills of the Blue Mountains in Oregon, but often is outyielded by Hybrid 128 when sown in the fall.

Six samples of the Redchaff variety have been milled and baked, all of which have come from commercial sources in the sections where it is grown. The data, presented in Table 60, show the variety to average low in crude protein, water absorption of flour, and loaf volume, and to be hardly equal to Jenkin or Hybrid 128 for milling and bread making.

SUMMARY OF MILLING AND BAKING DATA ON THE VARIETIES OF WHITE WHEAT.

A summary of the milling and baking data on the varieties of white wheat is shown in percentages of Pacific Bluestem in Table 73 and graphically in Figure 11. These are from the data presented in Tables 62 to 72, inclusive.

Bobs, Federation, Galgalos, Hard Federation, and White Federation have the highest loaf volumes, and Galgalos the highest protein content. Bobs, Talimka, White Federation, and Goldcoin have the highest flour yield. The data presented show that Bobs, Hard Federation, White Federation, Federation, and Galgalos are among the best of the white wheats for bread making. Baart, Dicklow, and Pacific Bluestem are of good milling and baking quality, while Goldcoin and the club wheats, Hybrid 128 and Little Club, are very low in bread-making qualities. Talimka shows rather good milling and baking qualities, but is not promising as a commercial wheat.

TABLE 73.—*Summary of milling and baking data, in percentage of Pacific Bluestem, on comparable samples of 11 other varieties of white wheat grown during one or more of the seven years from 1915 to 1921, inclusive.*

Variety.	Test weight per bushel (mill-cleaned).	Crude protein of wheat.	Milling yields.			Water absorption of flour.	Volume of loaf.	Weight of loaf.	Texture of loaf.	Color of loaf.	Ash in flour.
			Straight flour.	Shorts.	Bran.						
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Pacific Bluestem	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Baart	102.7	101.5	100.4	105.8	93.6	100.7	109.0	100.2	102.5	104.8	96.0
Bobs	103.7	94.8	107.9	100.7	69.1	105.6	122.9	101.6	107.4	108.4	102.0
Dicklow	96.3	100.0	100.3	92.4	105.7	100.2	106.5	99.2	101.3	102.4	100.0
Federation	99.7	91.7	103.4	98.5	88.6	99.8	115.9	101.6	104.0	101.5	92.0
Galgalos	102.1	107.4	101.1	102.1	93.1	108.5	115.7	104.1	104.7	103.0	102.0
Goldcoin	102.6	85.4	106.0	91.1	85.7	93.1	86.2	96.6	97.5	101.8	94.0
Hard Federation	102.7	100.8	103.8	116.2	74.6	110.4	114.1	103.3	103.8	106.7	94.0
Talimka	103.7	98.6	107.1	88.7	83.5	107.1	110.2	102.7	104.4	102.7	88.5
White Federation	101.9	95.9	106.2	116.9	67.2	110.5	113.1	103.5	103.9	104.4	102.0
Hybrid 128	102.1	87.7	104.0	92.5	91.2	96.5	88.0	99.8	96.9	98.2	94.0
Little Club	99.8	101.5	101.9	94.3	97.1	100.4	100.5	100.2	99.2	98.0	98.0

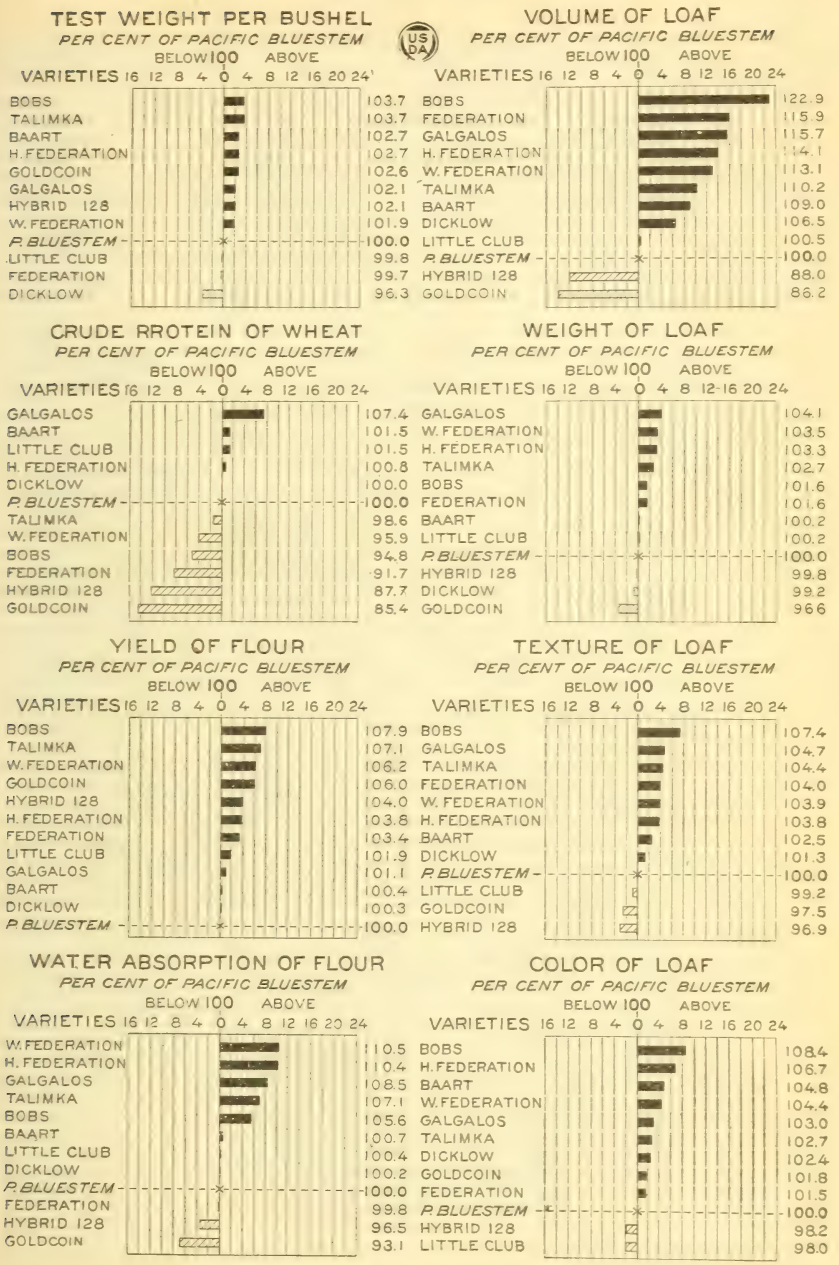


FIG. 11.—A comparison of the milling and baking data, in percentage of Pacific Bluestem, from samples of each of 11 other varieties of White wheat grown under comparable conditions with Pacific Bluestem. (Data from Table 24.)

SUMMARY OF MILLING AND BAKING DATA ON VARIETIES FOR ALL CLASSES.

Figures 12 to 25, inclusive, give graphic comparisons of the average, maximum, and minimum results from all samples of the various varieties discussed in the preceding paragraphs.

The various quality factors are presented in separate figures in such a manner that comparisons can be made between varieties of the same class and between varieties of different classes and at the same time show the relative quality of the different classes. The varieties are arranged within each class in the descending order of their averages. The class averages shown include the results of the samples listed under the varietal names and those from samples of unknown variety.

It is believed that the results shown in the various figures are generally representative of the quality of the varieties and classes as generally marketed, except in the case of the soft red winter class and several of its varieties. In the case of this class, a majority of the samples tested were obtained from the Rocky Mountain and Pacific Coast States, producing only a small proportion of the wheat of this class, the quality of which is generally considered as being inferior to that of the soft red winter wheats grown in the Eastern States, where most of this wheat is produced.

Comparison of the data in Figures 12 to 23, inclusive, with respect to number of samples for the respective classes and varieties, will show some variation. This was occasioned by the fact that on some samples the test for certain of the quality factors was not made, as in the case of crude protein of wheat and ash content of flour, or was purposely omitted, as in the case of bread color score for smutty wheat samples.

Figure 12 shows a comparison of the test weights per bushel of the various wheat varieties on the basis of dockage-free wheat.

The various classes, considered from the standpoint of their average test weight, rank from high to low as follows: durum first, hard red winter second, soft red winter third, white fourth, and hard red spring last. Among all the classes the highest average shown is 63.2 pounds for the Sonora variety of the white class and the lowest average is 50.4 pounds for Dakota of the hard red spring class. The greatest individual test weight shown is 67.5 pounds for a sample of the Prelude variety of the hard red spring class and for one of Sonora of the white class. The lowest minimum test weight shown is 37.7 pounds for a sample of the Dakota variety of the hard red spring class. The class of wheat showing the greatest range between the variety averages and between minimum and maximum within the varieties is that of hard red spring.

The test weight per bushel of the various varieties on the basis of mill-cleaned wheat is shown in Figure 13. It will be noted that the range of the classes and of the varieties within the classes is almost the same as in the case of the dockage-free wheat basis. The ranges between varieties and between individual samples of a variety, however, are a little less.

Comparison of Figure 12 with Figure 13 shows that the test weight per bushel of the mill-cleaned wheat is generally about a pound heavier than that of the dockage-free wheat. There are two excep-

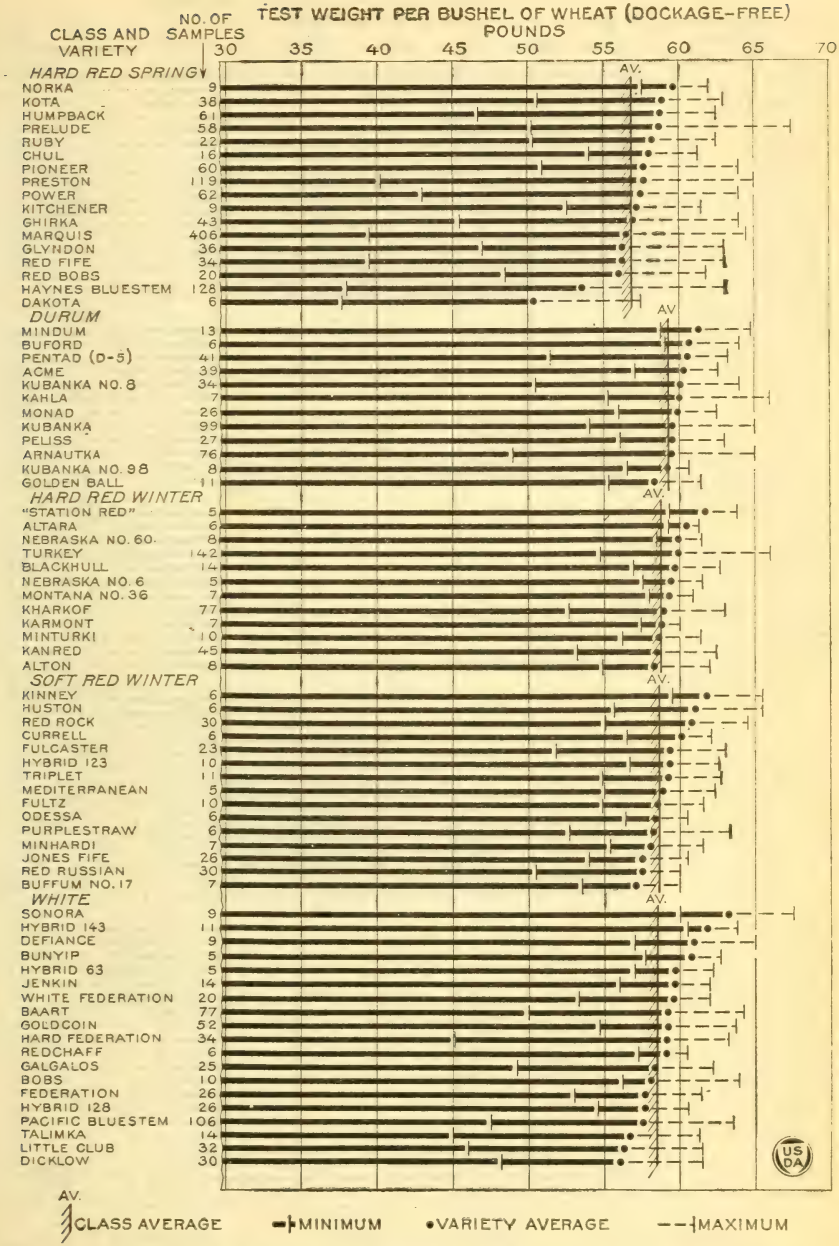


FIG. 12.—A comparison of the minimum, average, and maximum test weights per bushel (dockage-free basis) of the wheat samples of the various commercial classes and of varieties within each class.

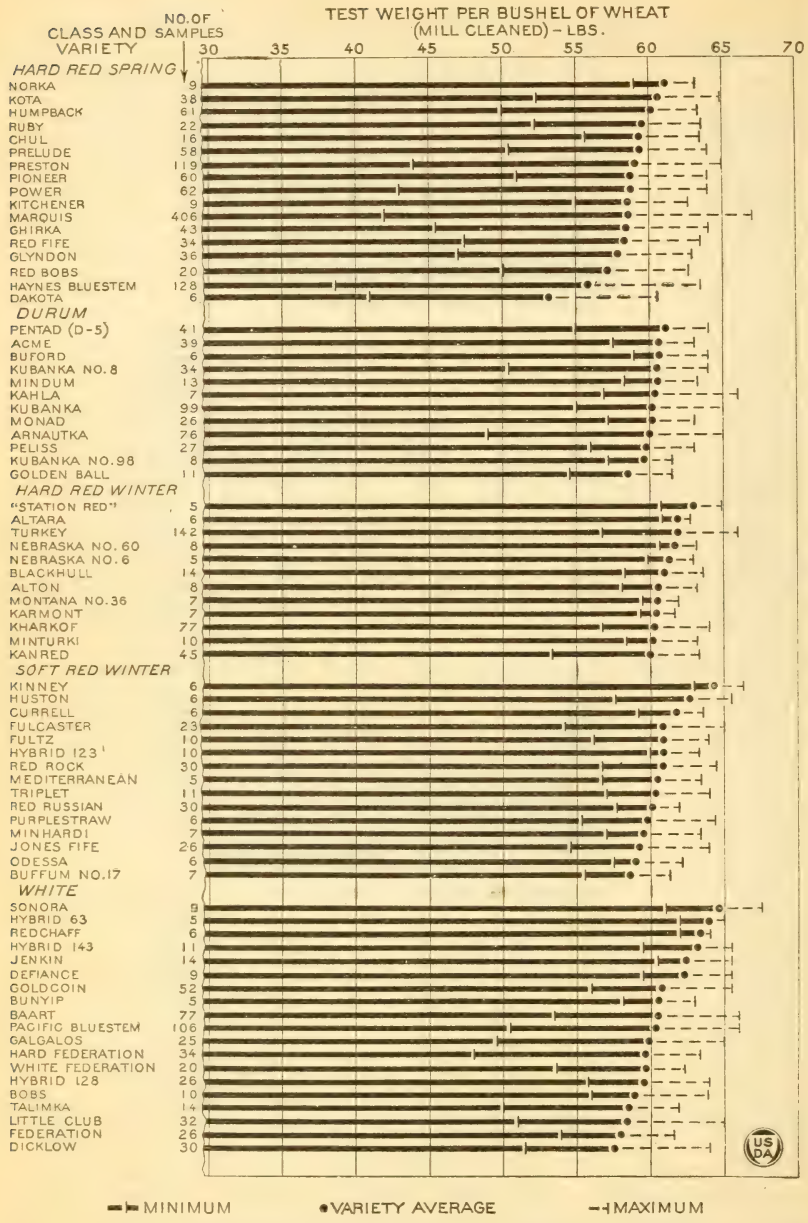


FIG. 13.—A comparison of the minimum, average, and maximum test weights per bushel (mill-cleaned basis) of the wheat samples of the various commercial classes and of varieties within each class.

tions to this rule, the Buford and Mindum varieties of the durum class. In the case of the former variety, no difference is shown in average test weights, and in the case of the latter, the average test weight of the mill-cleaned wheat was actually lower than that of the dockage-free wheat. Although this is the only variety that shows a decrease in average test weight per bushel after cleaning and scouring, it is not an uncommon occurrence for individual samples of other durum varieties to show similar results. On the other hand, this very rarely occurs in samples of other classes of wheat.

Figure 14, in which a comparison of the crude protein content of the various varieties is presented, shows the durum class with the highest average, hard red spring second, hard red winter third, white fourth, and soft red winter lowest. The highest average of the varieties is 16.6 per cent for Prelude of the hard red spring class. The lowest average shown for any variety is 9.1 per cent for Sonora of the white class. The greatest protein content shown for any individual sample is 21.2 per cent for a sample of Pioneer in the hard red spring class, and the lowest is 6.5 per cent for a sample of Sonora in the white class.

In the matter of average flour yield, Figure 15 shows the hard red winter class with the highest, soft red winter second, white third, durum fourth, and hard red spring lowest. The Mindum variety of the durum class, with a yield of 75.3 per cent, shows the highest average for the varieties and Ghirka of the hard red spring with 66.6 per cent the lowest average. The least range in flour yield between varieties is shown in the hard red winter class. It is significant that this class also showed the least range in test weight per bushel. The highest individual yield was 82.9 per cent for a sample of the Mindum variety of the durum class, and the lowest was 45.7 per cent for a sample of the Preston variety of the hard red spring class.

A study of Figures 12 and 15 shows that although the test weight per bushel of dockage-free wheat is a fair indication of flour yielding capacity, it does not always follow that the variety or class having the highest average test weight per bushel yields the highest average percentage of flour. This is well illustrated in the case of Alton, a variety of the hard red winter class, which shows the highest average test weight for its class and yet yielded the lowest average percentage of flour.

In average yield of bran, as shown in Figure 16, the classes rank as follows: Hard red spring highest, soft red winter second, hard red winter third, white fourth, and durum lowest. Considering the relative yields of flour, bran, and shorts of the different classes, it would appear that the hard classes of wheat, namely, durum, hard red winter, and hard red spring, produce a higher proportion of shorts to bran than do the soft wheats. In other words, other factors being equal, the softer the wheat, the greater the proportion of bran to flour and shorts. This may be due in part to a thicker coating of bran, or to the inability of the miller to mill off the aleurone and endosperm particles from the soft wheat bran as readily as from that of the hard wheats.

The highest individual yield of bran obtained was 27.6 per cent for a Haynes Bluestem variety of the hard red spring class and the lowest was 6 per cent for a Pacific Bluestem variety sample of

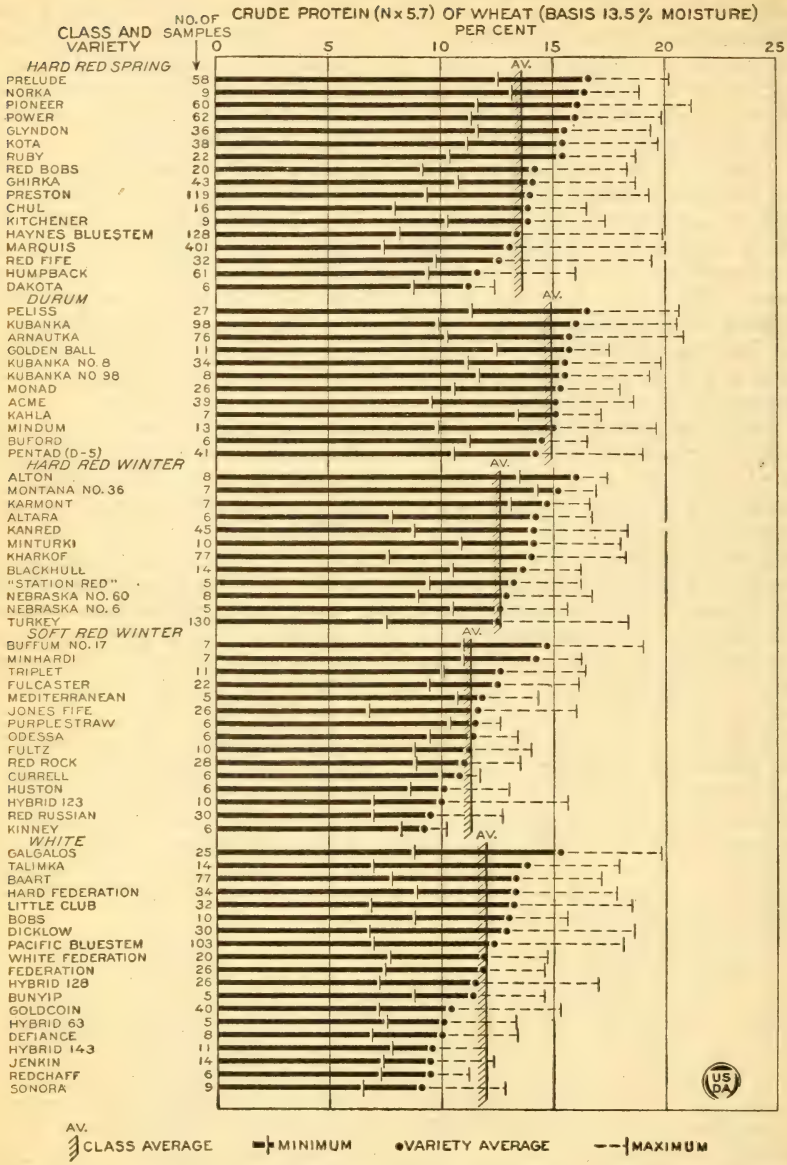


FIG. 14.—A comparison of the minimum, average, and maximum crude protein contents of the wheat samples of the various commercial classes and of varieties within each class.

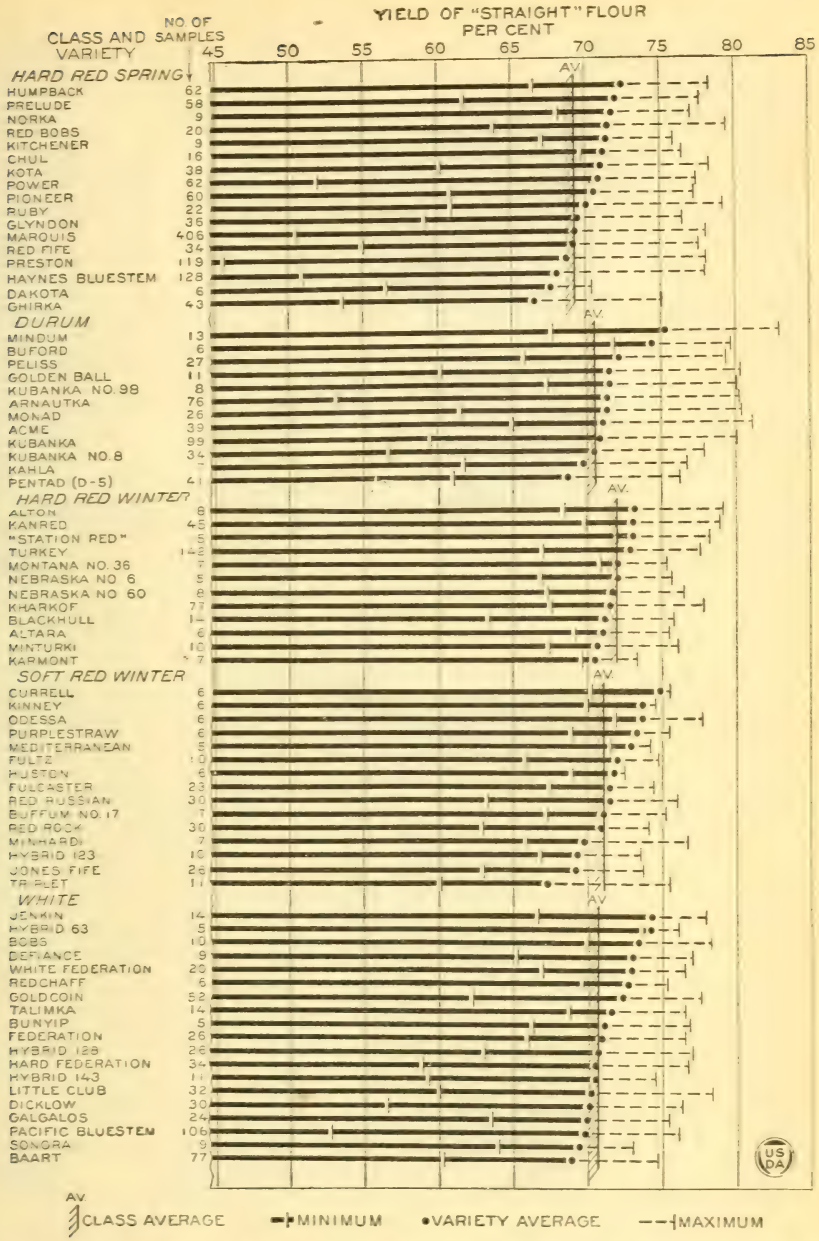


FIG. 15.—A comparison of the minimum, average, and maximum percentage yield of "straight" flour of the wheat samples of the various commercial classes and of varieties within each class.

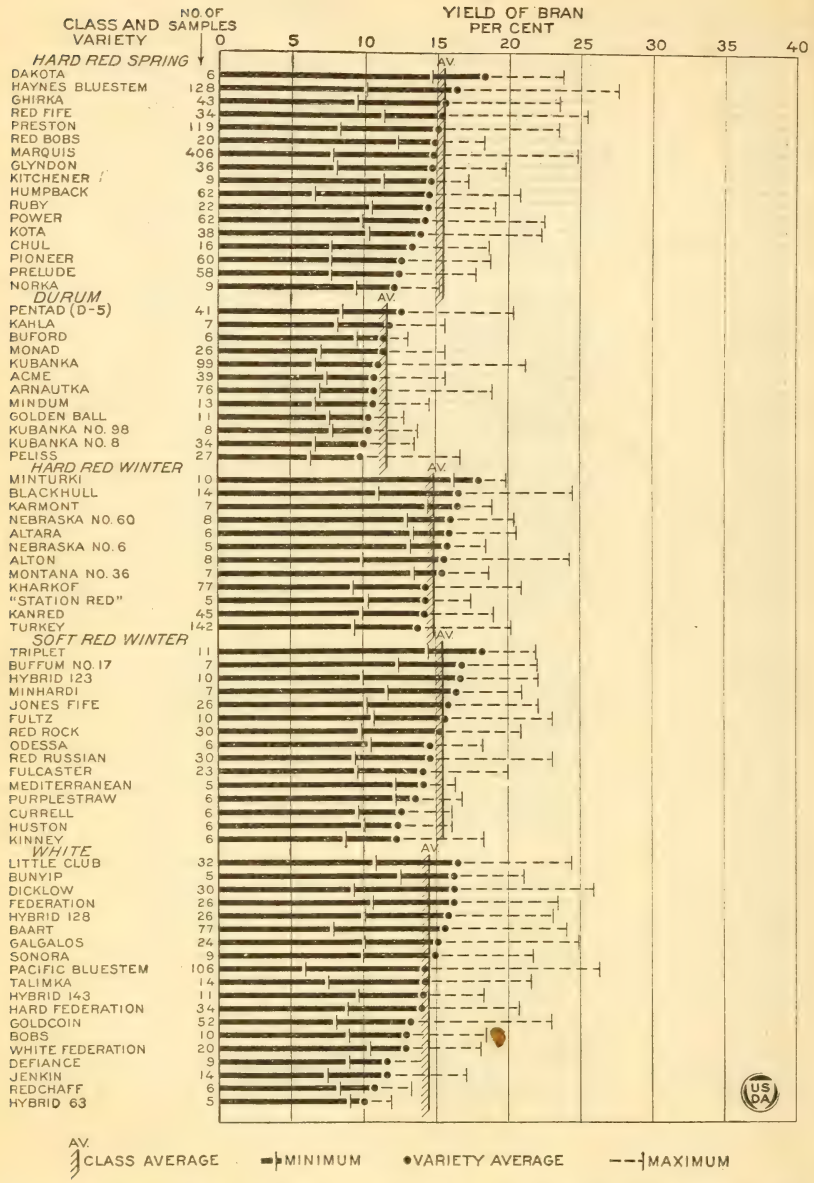


FIG. 16.—A comparison of the minimum, average, and maximum percentage yield of bran of the wheat samples of the various commercial classes and of varieties within each class.

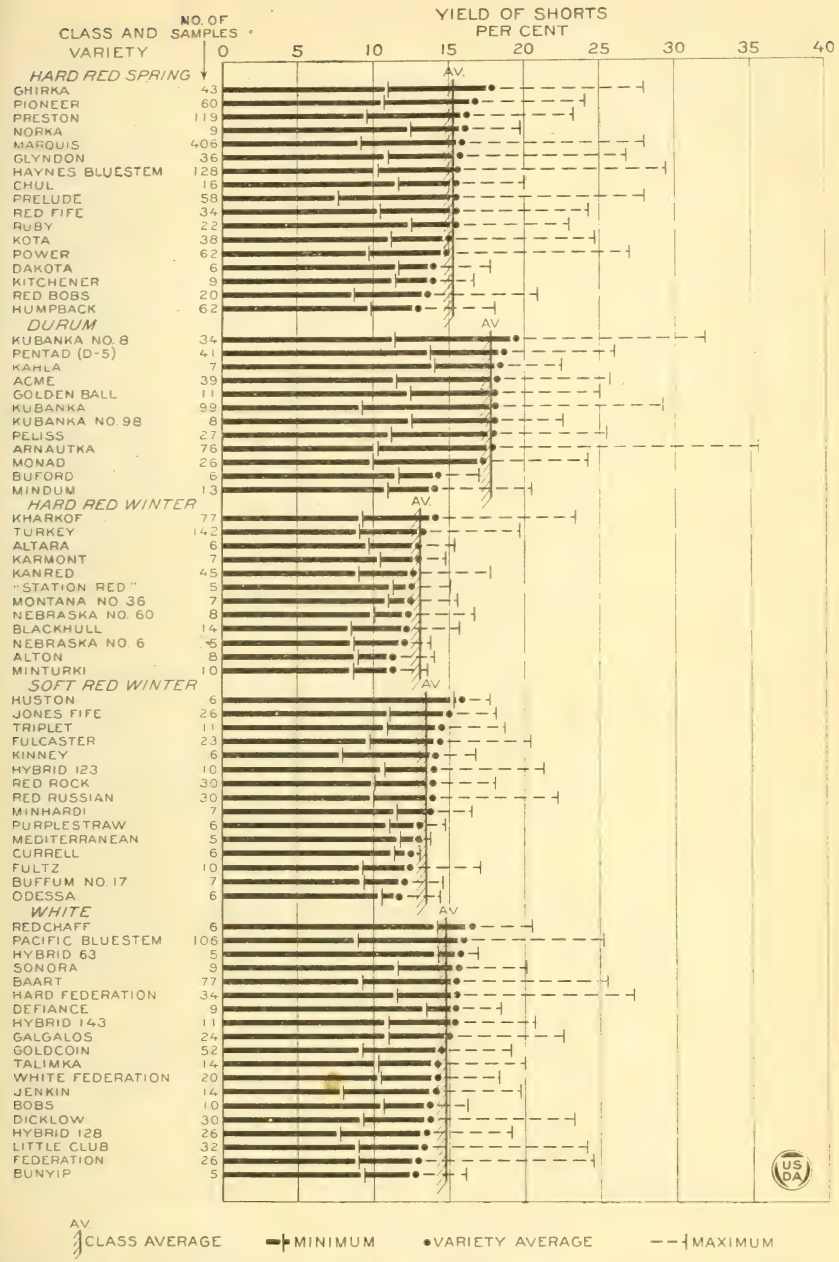


FIG. 17.—A comparison of the minimum, average, and maximum percentage yield of shorts of the wheat samples of the various commercial classes and of varieties within each class.

the white class. The highest individual yield of shorts was 35.5 per cent for an Arnautka sample of the durum class and the lowest was 7.7 per cent for a Prelude variety sample of the hard red spring class. A graphic presentation of the yield of shorts from a number of varieties is given in Figure 17.

In the matter of average water-absorbing capacity of flour, Figure 18 shows the classes to rank as follows: durum, highest, with 62 per cent; hard red winter, second, with 60 per cent; hard red spring, third, with 59.4 per cent; white, fourth, with 56.8 per cent; and soft red winter, lowest, with 55.9 per cent. The highest average shown for any variety is 66.7 per cent for the Peliss variety of the durum class. This variety also shows the highest water absorption for an individual sample, namely, 74.3 per cent. The variety of lowest average test is Humpback of the hard red spring class. The lowest individual test shown for any sample is 50 per cent for the Goldcoin and the Jenkin varieties of the white class.

The comparison of the loaf volumes in Figure 19 for the various classes and for the varieties of the classes, shows the class hard red spring to have the highest average, hard red winter second, durum third, soft red winter fourth, and white the lowest. The highest average shown for the varieties is 2,358 cubic centimeters for Dakota of the hard red spring class, and the lowest is 1,536 cubic centimeters for Goldcoin of the white class. The highest individual loaf volume shown is 3,125 cubic centimeters for a sample of Pioneer of the hard red spring class. The hard red winter class has the distinction of showing the least range between averages for varieties of a class.

The highest average weight of loaf shown in Figure 20 for the classes as obtained from the 340 grams of flour used for each individual test is 507 grams for the durum class. The second highest average weight shown is 497 grams for the class hard red winter; the third highest is 493 grams for hard red spring; the fourth highest is 489 grams for soft red winter; and the lowest is 484 grams for the white class. The variety showing the highest average weight of loaf is Peliss of the durum class. This variety and class also showed the highest average water-absorbing capacity, a fact worthy of note, as it is significant of the relationship existing between these two factors. The highest individual weight shown is 542 grams for a sample of the variety Peliss, and the lowest is 435 grams for a sample of Jenkin variety of the white class.

The texture of loaf scores presented in Figure 21 show the hard red winter class with the highest average, durum second, hard red spring third, soft red winter fourth, and white lowest. The variety showing the highest average texture score is Bobs of the white class, and that showing the lowest average is Goldcoin of the same class. The highest individual score shown is 100 for a sample of the Fulcaster variety of the soft red winter class and a sample of the variety Pioneer of the hard red spring class.

The color of loaf scores presented in Figure 22 show the hard red winter class to average highest, white second, hard red spring third, soft red winter fourth, and durum lowest. The highest average score shown for the varieties is 94.3 for Bunyip of the white class and the lowest is 84.2 for Mindum of the durum class. The highest individual sample score was 100, the honor for which was shared by the six varieties Marquis, Pioneer, and Haynes Blue-

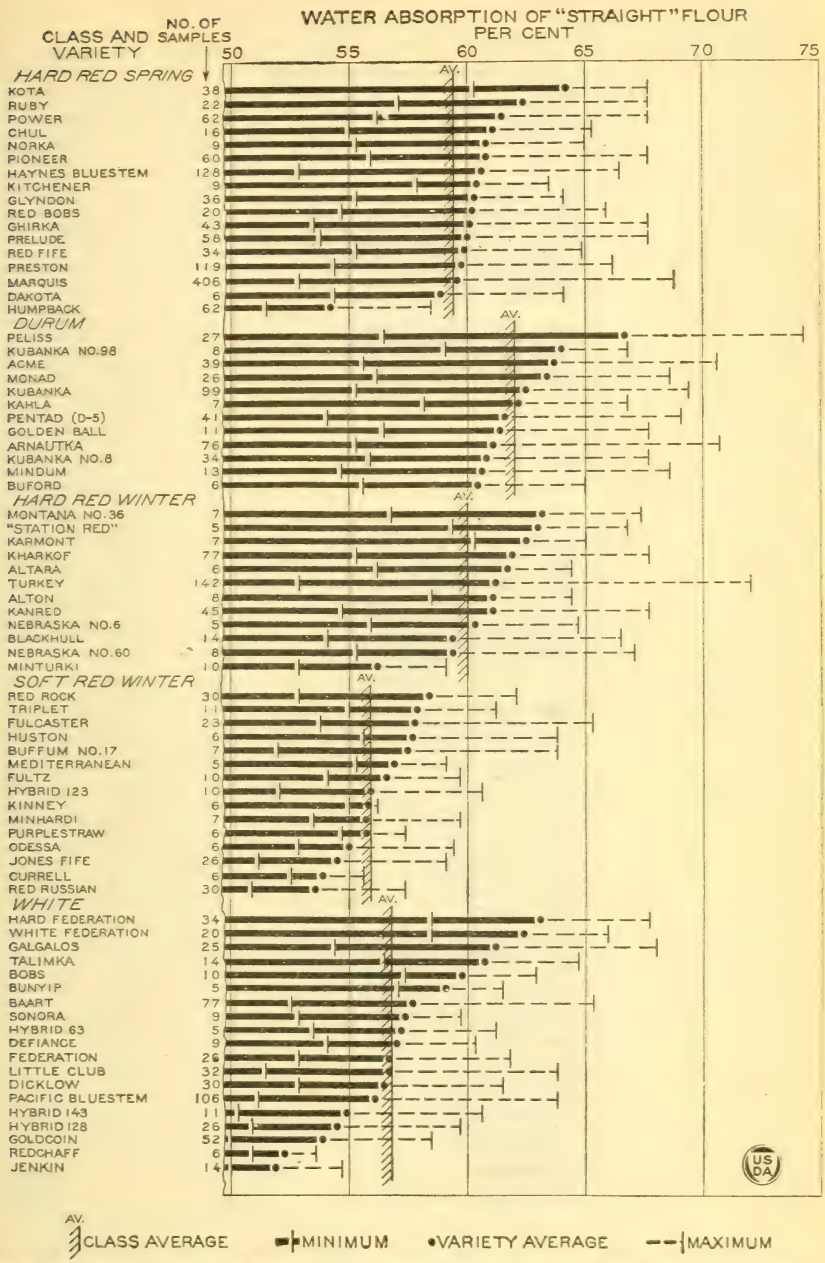


FIG. 18.—A comparison of the minimum, average, and maximum water absorption of flour of the wheat samples of the various commercial class, and of varieties within each class.

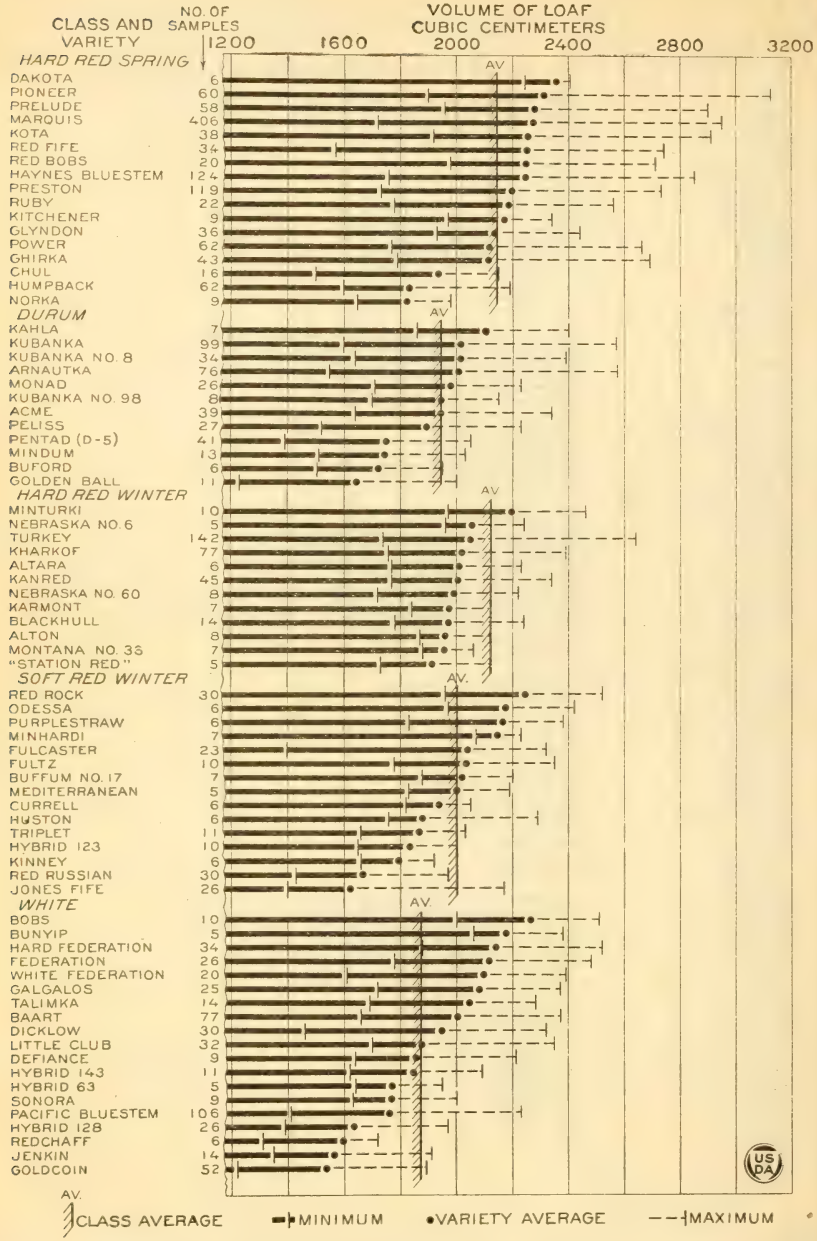


FIG. 19.—A comparison of the minimum, average, and maximum volume of loaf of the wheat samples of the various commercial classes and of varieties within each class.

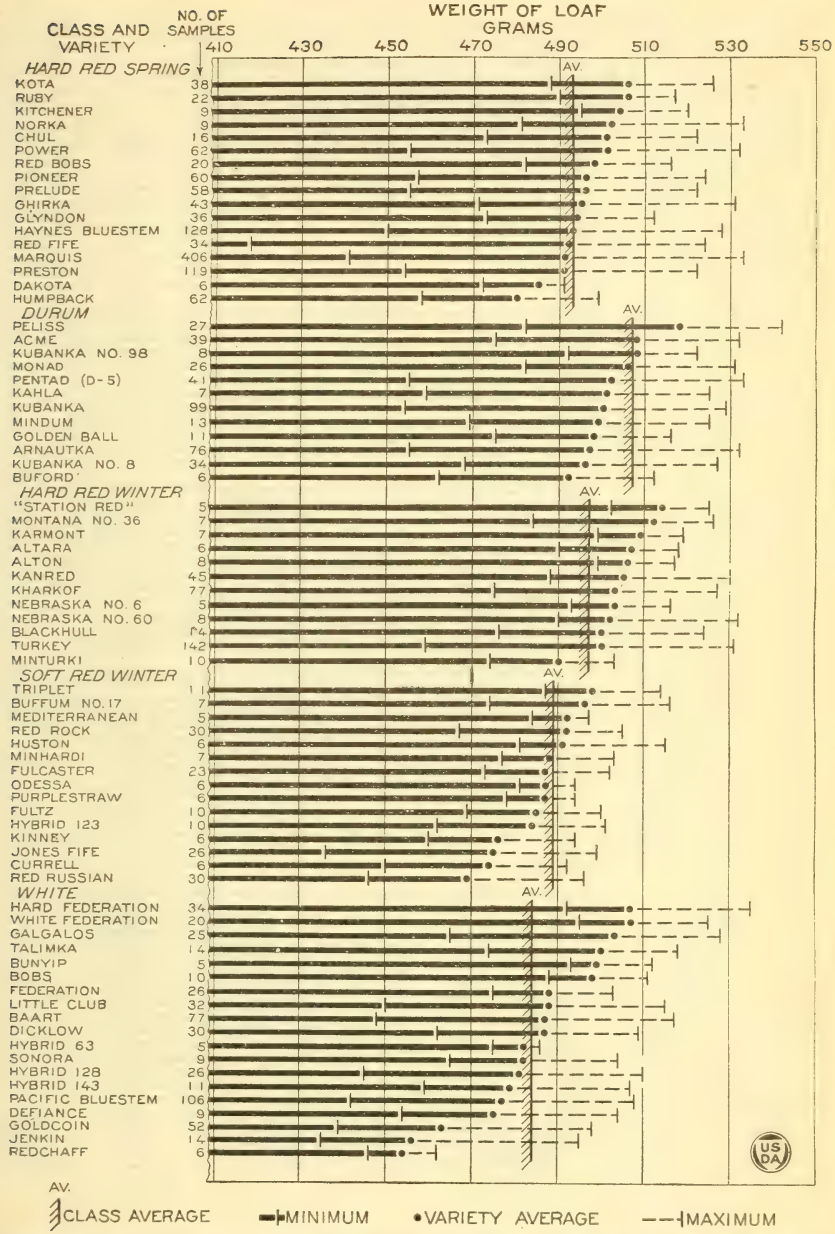


FIG. 20.—A comparison of the minimum, average, and maximum weight of loaf of the wheat samples of the various commercial classes and of varieties within each class.

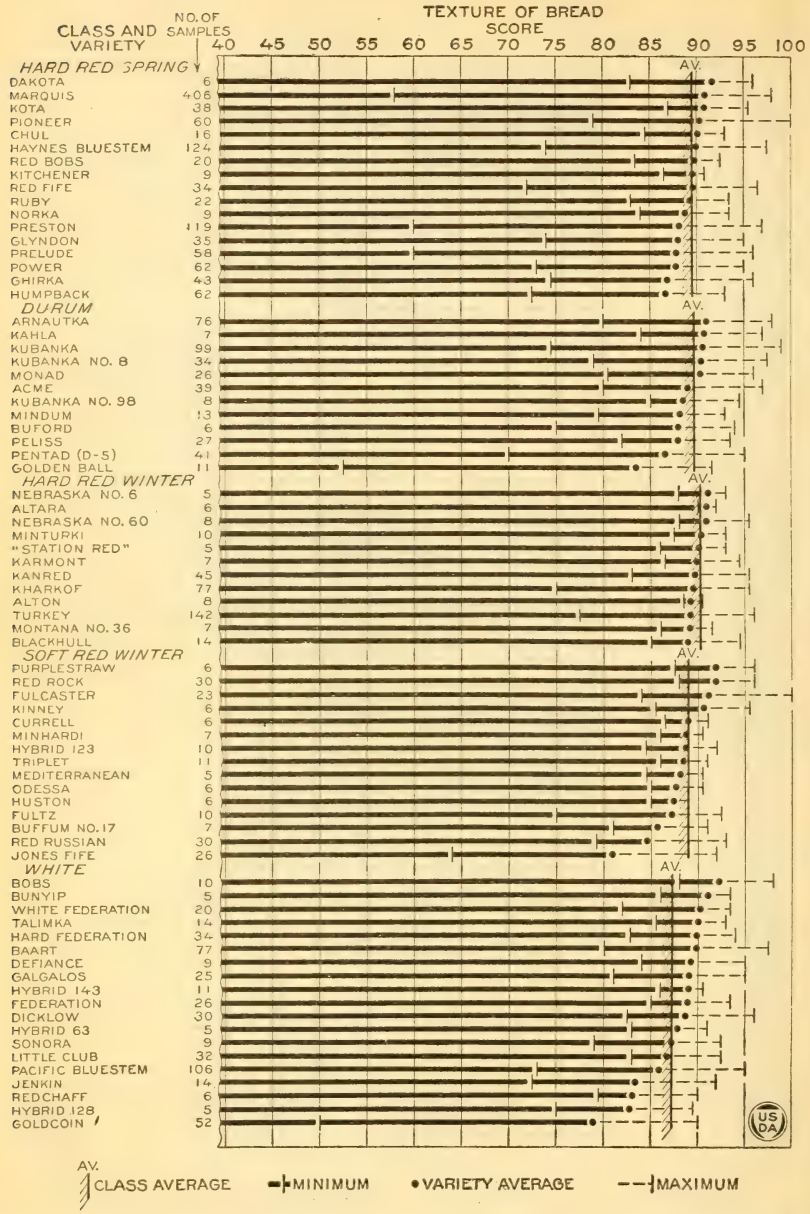


FIG. 21.—A comparison of the minimum, average, and maximum texture of bread of the wheat samples of the various commercial classes and of varieties within each class.

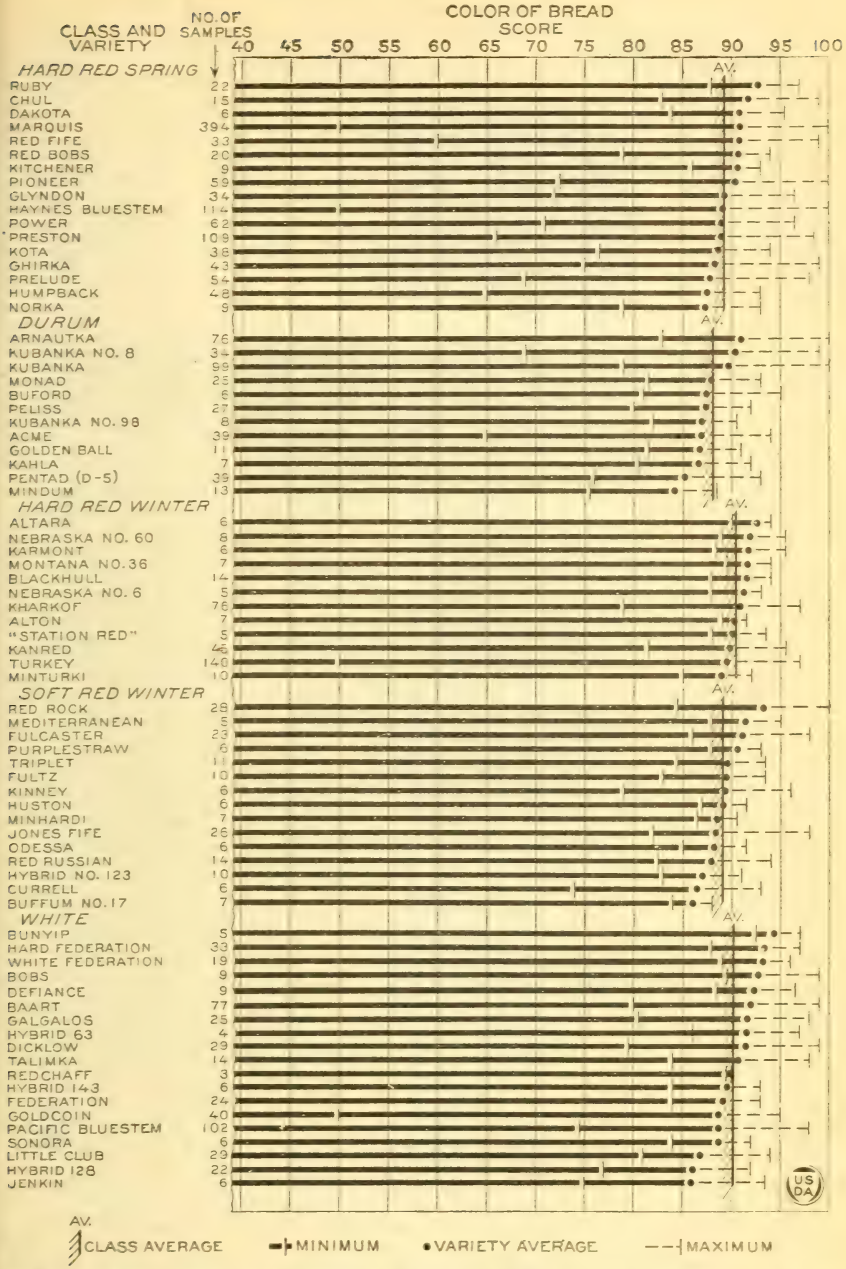


FIG. 22.—A comparison of the minimum, average, and maximum color of bread of the wheat samples of the various commercial classes and of varieties within each class.

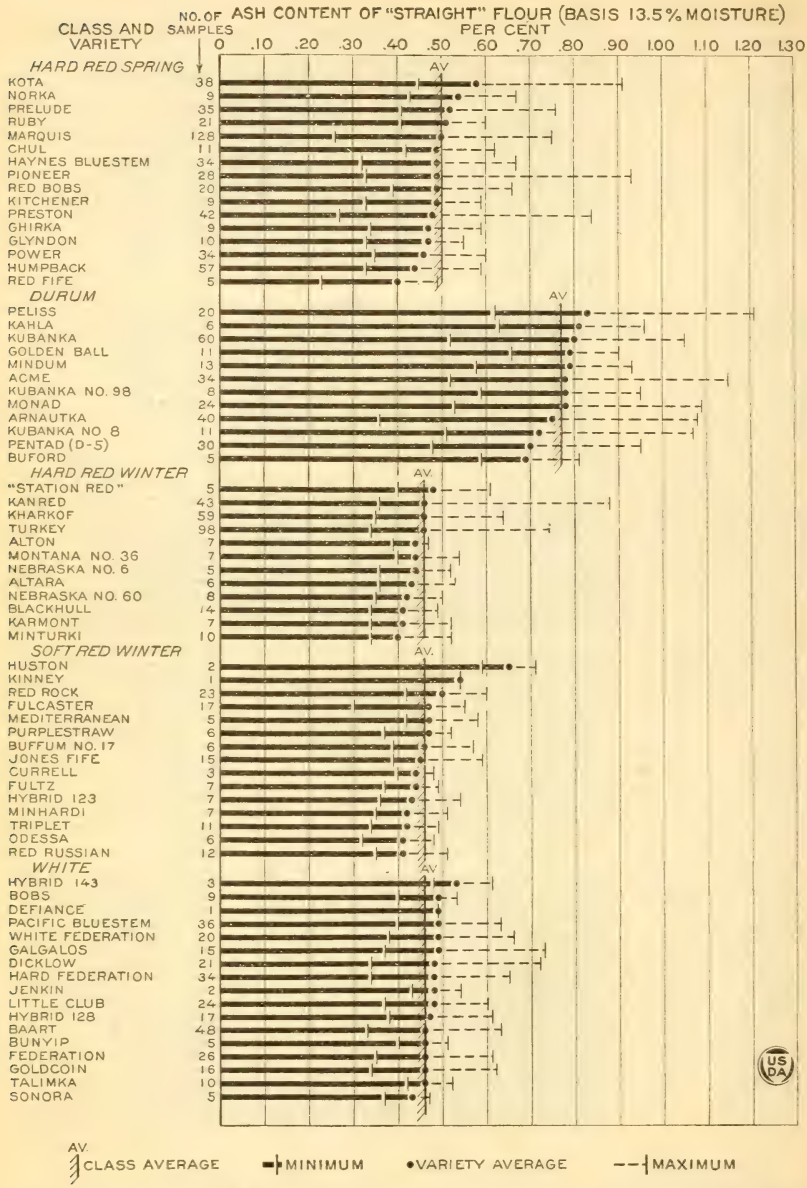


FIG. 23.—A comparison of the minimum, average, and maximum ash content of straight flour from the wheat samples of the various commercial classes and of varieties within each class.

stem of the hard red spring class, Red Rock of the soft red winter class, and Arnautka and Kubanka of the durum class.

The comparison of ash content of straight flour presented in Figure 23 shows the classes to rank as follows: Durum highest, with 0.77 per cent; hard red spring, second, with 0.50 per cent; and hard red winter and soft red winter, lowest, with 0.46 per cent each. It will be observed that even the lowest average shown for any variety of the durum class is considerably higher than the highest average of any variety of the other classes. The highest individual ash content shown is 1.21 per cent for a sample of the Peliss variety of the durum class, and the lowest is 0.26 per cent for a sample of the variety Marquis of the hard red spring class.

CONCLUSIONS.

New varieties of wheat must not only yield more but must be of sufficiently good quality to result in a higher acre return in order to replace the old varieties on the farms.

Wide variations in the principal milling and baking quality factors occur within a variety of wheat due to the season and locality in which the crop is grown. Results on less than five samples of a variety of wheat are not a reliable indication of its milling and baking value.

Marquis is the best variety of hard red spring wheat in milling and baking quality. It also is the most productive variety except in northwestern North Dakota and northeastern Montana where it is slightly outyielded by Red Fife and during the frequent seasons in which rust occurs in North and South Dakota when it is outyielded by the Kota variety. With the above exceptions, Marquis should replace all other varieties of hard red spring wheat in the northern spring wheat regions. Prelude, Pioneer, Ruby, and Kota are only slightly inferior to Marquis in quality and only slightly superior to Kitchener, Red Fife, Glyndon, Haynes Bluestem, Power, and Preston.

Kubanka excels all other varieties of durum wheat in baking quality followed by Kubanka No. 8, Kubanka No. 98 (Nodak), Arnautka, and Peliss. Pentad, Buford, and Mindum are of poor baking quality. Baking quality, however, is not necessarily a measure of the macaroni value of durum wheats. Kubanka is the most generally adapted variety of durum wheat in North and South Dakota, but during seasons of severe rust, it is considerably outyielded by Acme and Monad. In Minnesota Mindum is more productive than Kubanka, while in Montana, Wyoming, and Colorado Peliss is the most productive durum wheat.

The three leading varieties of hard red winter wheat—Turkey, Khakof, and Kanred—are practically equal in milling and baking value. All of the varieties of hard red winter wheat are satisfactory for milling and bread making, although Blackhull, Minturki, and Alton are softer wheats and in some respects somewhat inferior to the others.

Kanred is the most productive wheat in the central hard red winter wheat region, but outside of this region Turkey and Kharkof, or selections from them yield about as well. Minturki is the highest yielding winter wheat in Minnesota. Blackhull yields nearly as well as Kanred in central Kansas.

The Red Rock variety has the highest bread-making qualities of the soft red winter wheats. Other good varieties are Purplestraw, Minhardi, Odessa, Fulcaster, Fultz, and Buffum No. 17. The poorest varieties in quality are Red Russian, Jones Fife, and Hybrid 123.

Bobs, Hard Federation, White Federation, Federation, and Galgalos are among the best of the white wheats for bread making. Baart, Dicklow, and Pacific Bluestem are of good milling and baking quality, while Goldcoin and the club wheats, Hybrid 128 and Little Club are low in bread-making qualities.

Baart is the most productive spring wheat in the dry sections of Washington, and is well adapted to central and eastern Oregon and drier sections of California. Hard Federation outyields Baart on the dry lands in Oregon. Federation and Dicklow are the most productive wheats on the irrigated lands in Idaho and Oregon. Hybrid 128, a winter variety of club wheat, is the most productive wheat in the subhumid sections of southeastern Washington and northeastern Oregon.

Comparison of the milling and baking qualities of the various classes of wheat shows hard red spring to have averaged lowest in test weight per bushel of dockage-free wheat, and in yield of "straight" flour, and highest in volume of loaf, while in yield of bran it was one of the two classes showing the highest percentages. It also averaged high in protein content and yield of shorts.

Durum wheat showed the highest average results in test weight per bushel of dockage-free wheat, protein content, yield of shorts, water absorption of flour, weight of loaf, and ash content of flour. This class averaged lowest in yield of bran and in color score of bread and was low in yield of flour.

Hard red winter wheat averaged highest in yield of flour, and in color and texture of bread, and second highest in test weight per bushel, yield of bran, water absorption of flour, and weight of loaf. It averaged lowest in yield of shorts.

Soft red winter was one of the two classes averaging highest in yield of bran. It averaged second highest in yield of flour. It averaged lowest in crude protein of wheat and in water absorption of flour, and second lowest in yield of shorts, and in weight, color, and texture of loaf. It was one of the three classes averaging lowest in ash content of flour.

White wheat did not excel in any factor. Its best points were its high color score and low ash content of flour. It averaged lowest in volume, weight, and texture of loaf, and second lowest in test weight per bushel and crude protein content of wheat, and in water absorption of flour.

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